ted States
artment of
iculture

Conservation
vice

Honolulu, Hawaii

North Kona Flood Plain Management Study

Basic Technical Data on Flood Plain Areas

In Cooperation with:

State of Hawaii
Department of Land
and Natural Resources

County of Hawaii

Kona Soil and Water
Conservation District

North Kona Flood Plain Management Study

Prepared by the:

U.S. Department of Agriculture
Soil Conservation Service
Honolulu, Hawaii

in Cooperation with the:

County of Hawaii
Kona Soil & Water Conservation District
Department of Land & Natural Resources, State of Hawaii

December 1984

FOREWORD

This study provides the state and county units of government with the basic hydrologic and hydraulic data concerning the flooding problems and possible alternatives in the rapidly growing North Kona area. This data is necessary for the enactment of sound flood plain management and land use programs. Included in this study are the following:

1. Identification of 7 drainageways that could cause flooding.
2. Determination of elevation-discharge relationships for each of the drainageways for the 10-year, 50-year, 100-year and 500-year frequency storms.
3. Delineation of flood plain areas in each of these drainageways for the 100-year and 500-year frequency storms on flood hazard maps with an aerial photo contour base.
4. Determination of existing conditions in each of the drainageways and proposed maintenance measures to correct possible flooding problems.
5. Identification of structural and nonstructural alternatives to alleviate the flooding problems in the Keopu/Hienaloli, Waiaha and Kaumalumalu drainageways.

This study was prepared by the Soil Conservation Service, U.S. Department of Agriculture, in cooperation with the Kona Soil and Water Conservation District, County of Hawaii, and the State Department of Land and Natural Resources. Special recognition goes to the Plans and Survey Division of the County of Hawaii, volunteers and directors of the Kona Soil and Water Conservation District, and private citizens for their guidance and efforts in carrying out this study.

NORTH KONA FLOOD PLAIN MANAGEMENT STUDY

TABLE OF CONTENTS

INTRODUCTION

Need for Study

Residents in the North Kona area are subject to increasing hazards from floodwater damages as land is put to higher utilization. Local units of governments (County of Hawaii and State of Hawaii) have an immediate need for flood plain information so that they may initiate sound flood plain management and land use programs in the study area.

Further, the need for this information was identified in the Island of Hawaii River Basin Report prepared by the United States Department of Agriculture's Soil Conservation Service (SCS), Economic Research Service, and Forest Service in cooperation with the State of Hawaii, Department of Land and Natural Resources (DLNR). The report states, "In the rapidly developing North Kona and Waiakea-Uka watersheds, channel improvements and floodwater diversions are needed to provide flood protection to adjacent lands and to provide suitable outlets for upstream areas. In addition to structural improvements, flood plain management and zoning are also needed to fully satisfy flood prevention needs and to prevent further flood damages."

Requesting and Participating Agencies

In September 1981, the County of Hawaii and the Kona Soil and Water Conservation District submitted a request to the SCS through DLNR for assistance in making a detailed flood plain management study of the North Kona area. In response to this request, a Plan of Work (POW) was prepared and completed in June 1982. The POW outlined the objectives and procedures to complete the study. Work on this study was initiated in November 1982.

Study Authorities

The SCS is authorized to provide technical assistance to state, federal and local governing bodies in carrying out flood plain management studies under Section 6 of the Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566, as amended). This is in accordance with Recommendation 9(c), of House Document No. 465, 89th Congress, 2nd Session; Executive order 11296, dated August 10, 1966; and USDA Secretary's Memorandums 1606 and 1607.

Chapter 179, Hawaii Revised Statutes, as amended, designates DLNR as the state agency responsible for coordination of the flood control and related activities in the various government agencies in Hawaii. DLNR, through its Division of Water and Land Development (DOWALD), is the agency responsible for implementing the statewide flood control program and for providing technical and financial assistance to the political subdivisions of the state (counties and Soil and Water Conservation Districts).

Limitations of the Study

The entire study area is characterized by underdeveloped or poorly defined drainageways, all subject to potential flooding. Special efforts were made to locate probable problem areas by interviewing local residents and studying storm damage reports. These efforts resulted in the identification of seven drainageways most likely to carry excessive storm runoff. It must be emphasized that this does not preclude the possibility of other unidentified drainageways also carrying damaging runoff. This is caused by several unpredictable circumstances: (1) development and clearing in both agriculture and urban areas will alter existing topography, (2) accumulation of sediment and debris in any of the identified drainageways could divert flow to form new drainageways not identified, and (3) a storm may be centered over areas of undefined and unidentified drainageways.

There also exists in the area the possibility of shallow, alluvial-type flooding resulting from overbank flows that remain unconfined. Such shallow flooding with average depths less than one foot, are not usually associated with channel flooding and flood profiles. Reliable determination of depths, extent of flooding, and direction of flow by normal open-channel hydraulics is difficult if not impossible. Because of the steep slopes of the existing terrain, attempts to confine such flows would result in hazardous velocities. Any one storm may not cover the entire area with alluvial flooding, but because of the possibility of sediment and debris altering the direction of flow, all areas may experience this type of flooding.

Finally, delineation of flood plain areas above the 1,600-1,800 foot elevations for all drainageways were impossible because of the lack of accurate topographic maps. Therefore, although the flood plain areas in this study are terminated at these elevations, this does not imply that the areas above are not subjected to flooding.

DESCRIPTION OF THE STUDY AREA

The study area, located on the west slopes of Hualalai and Mauna Loa mountains on the island of Hawaii, encompasses approximately 81,000 acres. It extends from the North/South Kona District boundary on the south to Kaloko Ahupua'a on the north and from the Pacific Ocean on the west to Hualalai Mountain on the east.

The area consists of a series of narrow subareas with underdeveloped drainageways that flow to the ocean. Seven intermittent drainageways totaling 30 miles in length were identified during the study as having flood hazard potential. They included the Kainaliu, Kawanui/Lehuula, Kaumalumalu, Holualoa/Horseshoe Bend, Waiaha, Hienaloli and Keopu drainageways (See Table No. 1).

Rainfall distribution varies with season and elevation throughout the area. Being on the leeward side of the island, the area is protected from the prevalent moisture laden northeast tradewinds by the Mauna Kea, Mauna Loa and Hualalai mountains. Land-water temperature differentials along the coast are sufficiently large on warm days to foster the development of sea-breeze circulation causing predominately convective type showers during the wet summer months of May through September. Occasional winter storms during November through February are caused by the passage of frontal systems referred to as "Kona storms."

The mean annual rainfall ranges from about 20 inches along the coast to 100 inches at an elevation of 3,000 feet with a gradual decrease thereafter to 20 inches at the peak of Hualalai.

Soils in the area may be classified into three major groups based on the occurrence of volcanic ash or organic matter covering the basaltic material. These groups are volcanic ash soils, organic soils, and young, unweathered lava.

The volcanic ash soils consist of the Kainaliu, Waiaha, and Honuaulu series which are found from sea level to 2,500 feet. Other volcanic ash soils occurring from 3,000 to 6,500 feet are the Hanipoe, Manahaa, Honaunau, Kealakekua and Puukala series. These soils are used for coffee, macadamia, truck crop, pasture, woodland and wildlife.

Soils having a thin deposit of organic matter over pahoehoe or aa lava are the Keei, Kiloa, Kahaluu, Kaimu, Kona, Kekake, Mawae, Puna and Punaluu series. These soils range from sea level to 7,000 feet. They are used for grazing, wildlife and woodland.

Young, unweathered lava with little or no covering of volcanic ash or organic matter is found above 7,000 feet. These lands are sparsely vegetated with scrub trees, mosses, lichens and shrub species to 8,500 feet and barren above that elevation. These lands have little or no agricultural value but contain important wildlife habitat. Barren lava flows also cross the study area with narrow fingers in the higher elevations.

NATURAL VALUES

The flood plain areas in this study are composed of urban, agricultural and forest land uses. In addition, based on a preliminary survey, there are historical, archaeological, recreational, wetland and endangered plants and animals sites scattered throughout the study area.

Urban land which occurs mostly in the lower areas of the flood plains, consist of single/multiple residential and commercial land in the Keopu, Hienaloli, Waiaha, Holualoa/Horseshoe Bend and Kaumalumalu drainageways below the Mamalahoa Highway. The urban lands in the flood plains of the Kainaliu and Lehuula/Kawanui drainageways are along the Mamalahoa Highway

Agricultural land consists mostly of pasture throughout all the drainageways with some scattered orchard crops of coffee and macadamia nuts. Although there are extensive farming operations in the study, the Agricultural Lands of Importance to the State of Hawaii (ALISH) designation does not identify any lands in the flood plains as prime farm land. This is primarily due to the steep slopes, stoney surface layers and inadequate moisture in the area. Forest lands are found mainly in the upland portions of all the drainageways.

There are several hundred historical and archaeological sites within the Kona Field System (Site #1) that lie in this study area. These sites are listed in the Statewide Archaeological Inventory and include the Kamoa Point Complex, Kamehameha III's Birthplace, Greenwell Store, Kahaluu Historic District, Keauhou Holua Slide, Kuamoo Burials and the Honokahau Settlement. Because of the vast number of sites in the study area, the Division of State Parks recommends that in compliance with 36 CFR 800 (Advisory Council on Historic Preservation's Procedure for the Protection of Historic and Cultural Properties), archaeological mitigation will be necessary prior to any construction and/or grading activity within any flood plain area.

Most of the recreational sites in the area are located along the shoreline, in areas prone to flooding. Several sites that may be within the flood plain areas include the Hale Halawai Beach, Pahoehoe Beach, and White Sands Beach parks, Disappearing Sands Beach, the Hada's, Kahului shorebreak, Banyan's and Magic Sands surf sites according to the State Parks Division of DLNR.

Since all the drainageways are ephemeral, there are no wetlands of significance in the flood plain areas. However, wetlands do exist outside these areas.

There are several threatened or endangered animals that inhabit or have been seen in the study area. They include the Hawaiian Hoary Bat, Hawai'i Akepa, Hawai'i Creeper, Hawaiian Coot, Hawaiian Crow, Hawaiian Goose, Hawaiian Stilt, Hawaiian Hawk and the Green Sea Turtle. The U.S. Fish and Wildlife Service recommends a detailed study be conducted prior to any proposed project action in accordance with Section 7 of the Endangered Species Act.

FLOOD HISTORY

Flood problems in the area are due to the steep topography and the youthful geology. As most reaches in the individual drainageways are underdeveloped and shallow, they cannot carry floodwaters within bank during intense rainstorms. Overbank flow occurs and carries with it rocks, debris and sediment downslope which cause damages to agricultural lands, residential and commercial properties and public roads. Since all the drainageways are intermittent, accumulated debris and rocks can clog them to easily alter the streamflow and define a new flood prone area.

A 100-year storm within the study area will inundate about 545 acres and a 500-year storm will inundate approximately 753 acres. A breakdown of acres inundated by drainageways is found in Table No. 1.

Table No. 1
Drainageway Acres Inundated and Length

Drainageway	Acres Inundated		Length
	100-Year	500-Year	(Miles)
Keopu	112	155	5.4
Hienaloli	54	69	3.8
Waiaha	125	172	6.0
Holualoa/Horseshoe Bend	68	107	5.6
Kaumalumalu	71	99	3.9
Kawanui/Lehuula	47	66	2.8
Kainaliu	68	85	2.5
Total	545	753	30.0

Storms in the area occur in a few drainageways and not over the whole study area resulting in storm damages being concentrated in specific drainageways. Since 1955, there have been 22 storms that have damaged the area. The most recent major storms occurred in October 1968, October 1974, and February 1982.

October 1968

Damages were estimated at about $950,000, and were centered in the Holualoa/Horseshoe Bend and Kaumalumalu drainageways. Public facilities including county roads, bridges and domestic water systems suffered damages in excess of $400,000 from floodwater, debris and erosion. Kuakini Highway and Alii Drive were washed out in several locations causing disruption to traffic. A 100-foot by 40-foot deep section of Mamalahoa Highway at Holualoa was ripped out by the raging floodwaters. Floodwaters also damaged about 40 residences along Mamalahoa Highway and Alii Drive. Agricultural damages to coffee, macadamia nuts and pasture were estimated at about $300,000.

The United States Geological Survey (USGS) Waiaha Stream at Luawai stream gage (No. 16759300) measured a peak discharge of 3,100 cfs which, based on the Water Resources Committee frequency analysis, approximates a 25-year storm event.

October 1974

The storm was centered over the area between Holualoa and Kainaliu with most of the damages occurring in Kainaliu town and the Holualoa/Horseshoe Bend Drainageway below Kuakini Highway. Mamalahoa Highway through Kainaliu was flooded with a foot of mud and water from the watershed above the University of Hawaii Kona Experiment Station, Ben Franklin Store and Sandy's Drive Inn. Macadamia nut orchards above Kainaliu suffered losses in excess of $25,000.

Several homes in the Alii Kai Subdivision by the Holualoa/Horseshoe Bend drainageway were flooded. Floodwaters also caused $50,000 damages to the stockpiled material of the Shield Pacific Company. Water and sediment were up to 2 feet deep on Alii Drive.

This storm was of short duration and the rain gage at Kainaliu (No. 73.2) measured 3.77 inches in a 2 hour period, which approaches a 100-year event.

February 1982

The storm was centered over the North Kona area from Keopu to Kaumalualu drainageways. The Big Island Civil Defense estimated damages in excess of $3 million. Hualalai Road, Mamalahoa Highway north of Holualoa and Kuakini Highway near the Pottery Steakhouse were closed due to floodwaters.

Keopu Drainageways suffered the most damages with over $1 million losses to roads, residences in the Keopu Heights Subdivision and commercial buildings in Kailua town. The Keopu Heights Subdivision road was totally destroyed with pavement, power conduits and water pipeline being torn out by rushing floodwaters leaving residents stranded without power, water and/or access to their homes. Estimated cost of repairing the road was $1.3 million. The Keopu Makua Subdivision road suffered $70,000 worth of damages to pavement and sediment.

Figure No. 1 Keopu Heights Subdivision Road

Figure No. 2 Highwater mark at 7557 Kawala Street in Lono Kona Subdivision of Keopu Drainageway

Floodwater and sediment from Waiaha Drainageway inundated several homes in the Hillcrest Subdivision below Hualalai Road with about 2 feet of water. Further downstream, a domestic water main on Kuakini Highway was broken by the rushing waters and the outlet of Waiaha Drainageway by the Kona Tiki Hotel on Alii Drive was overtopped.

The undersized culvert at the outlet of Holualoa Drainageway at Alii Drive was overtopped and water was about 2 feet deep in the vicinity of the Bali Kai condominiums. Water backed up into the Alii Kai Subdivision and flooded several homes.

Agricultural damages to macadamia nut and truck crops were estimated to be about $900,000 by the County Emergency Board of the U.S. Department of Agriculture.

The USGS stream gage Waiaha Stream at Luawai (No. 16759300) measured a peak discharge of 3,500 cfs or about a 25-year frequency storm. Rain gages at Lanihau (No. 68.2) and Holualoa (No. 69.16) also had rainfall amounts that approximated a 25-year frequency storm.

EXISTING FLOOD PLAIN MANAGEMENT

Potential flood damages to existing development and possible loss of life could be alleviated or lessened through existing flood plain management programs by the County of Hawaii. These are found in Hawaii County Code, Chapter 22, Flood Hazard Control adopted on May 5, 1982 as Ordinance No. 778 and related building and planning chapters in this code.

The County of Hawaii entered the National Flood Insurance Program (NFIP) under Article 2 of Ordinance No. 778 pursuant to the U.S. National Flood Insurance Act of 1968 (Public Laws 90-418 and 91-152), as amended, and the U.S. Flood Disaster Protection Act of 1973 (Public Law 93-234), as amended. NFIP is administered by the Insurance and Mitigation Division of the Federal Emergency Management Agency formerly the Flood Insurance Administration in the Department of Housing and Urban Development. Flood insurance is available at subsidized rates to homeowners and businesses within or adjacent to flood areas that are delineated on Federal Insurance Rate Maps (FIRM).

Future development in the flood plain areas is regulated by Article 3 in Chapter 22 of the Hawaii County Code to reduce future flood damages to structures, and public facilities. All new construction and substantial improvements of residential and non-residential structures are required to elevate the lowest habitable floor, including basement to be at or above the base flood elevation (100-year flood elevation). New and replacement water supply and sanitary sewage system shall be designed to avoid contamination.

Chapter 22 is considered as a minimum requirement for flood hazard control and all construction shall also comply with the Zoning, Building, Electrical, Plumbing, Subdivision, Excavation, Fills, Grading, Grubbing, Stockpiling, and Erosion and Sedimentation Control chapters of the Hawaii County Code.

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT

To reduce the present and future damages, several alternatives were evaluated. With the exception of the "do nothing" alternative, each of the following structural and/or nonstructural alternatives could be implemented to complement each other.

"Do Nothing"

This "do nothing" alternative encompassed the continuation of existing county flood plain management policies under the Hawaii County Code. Areas in the study will progressively continue to suffer flood damages during storms due to more intensive land use. Residents in floodprone areas can reduce their financial losses by obtaining subsidized flood insurance through NFIP.

Nonstructural

1. Preserve and maintain the conservation and agriculture land use districts above Mamalahoa Highway.
2. Establish and maintain appropriate vegetative cover in high rainfall, sediment and debris-producing areas.
3. Enforce county grading ordinance to reduce erosion and sedimentation.
4. Enforce land use zoning to restrict future development within identified flood plain areas.
5. Initiate state/county tax incentives for keeping flood plain areas in recreational and/or open space use by:
    a. Reducing the tax rate for these designated areas.
    b. Allowing tax deductions to landowners for donation of these areas to the state or county.
6. Install flood warning system tied in to stream or rain gauges in the upper reaches of the drainageways.

Structural

1. Require all new developments to dispose of their runoff (up to the 10-year storm) on site.
2. Relocate or floodproof buildings within flood plain areas.
3. Improve road culverts and bridges to carry a larger discharge and provide additional ones where needed. Improve entrance design of culverts to prevent clogging by rocks, sediment and debris.
4. Provide a 100-year level of protection by installing diversions, channels, culverts and debris basins for the Keopu/Hienaloli, Waiaha and Kaumalumalu drainageways in accordance with SCS design criteria as follows:

Keopu/Hienaloli Drainageway (See Figure No. 3)

a. Increase the sediment storage capacity of the existing debris basin.

b. Reconstruct the existing transition for the debris basin.

c. Concrete line existing structural plate pipe arch culvert on the Hawaii Belt Road.

d. Construct a 12' X 6' reinforced concrete channel adjacent and to the north of the existing culvert from the debris basin to the ocean outlet.

e. Construct an unlined diversion with width (B) = 40', height (H) = 6', side slope (Z) = 1:1 to divert flow from Keopu Drainageway.

f. Purchase flood easement between the Hawaii Belt Road and the existing debris basin.

In lieu of providing a 100-year level of protection, a lesser 50-year level of protection could be provided by raising the sidewalls of the existing reinforced concrete channel approximately 2' from the debris basin to Hualalai Road. Additionally, items (a), (e) B= 40' and H = 6', and (f) would have to be included. However it should be noted, that the area below the debris basin would still be subject to residual damages from a 100-year storm.

Waiaha Drainageway (See Figure No. 4)

a. Construct unlined diversion above proposed debris basin with B = 60', H = 4', Z = 1:1.

b. Construct debris basin above the Queen Kaahumanu Highway.

c. Construct 40' X 5' reinforced concrete channel from Hawaii Belt Road to the ocean outlet.

d. Construct 3 reinforced concrete box culverts under Alii Drive, Kuakini Highway and Hawaii Belt Road.

Kaumalumalu Drainageway (See Figure No. 5)

a. Construct a debris basin above the proposed realignment of Alii Drive.

b. Construct an unlined diversion with B = 60', H = 6' and Z = 1:1 from the proposed realignment of Alii Drive to the ocean outlet.

c. Construct 3 reinforced concrete box culverts at Kuakini Highway, proposed realignment of Alii Drive and Alii Drive.

Holualoa/Horseshoe Bend Drainageway

a. Install channels and culverts for the Holualoa/Horseshoe Bend drainageways per the **Holualoa Drainage Study** by Shimabukuro and Associates.

PALANI ROAD

KUAKINI HIGHWAY

ALII DRIVE

KAILUA BAY

HUALALAI ROAD

12'x6' Concrete Culvert

Existing 12'X6' Concrete Channel

12'X6' Concrete Channel

HUALALAI ROAD

NOT TO SCALE

Structural Measures

Existing 3-84" SPPC

HAWAII BELT ROAD

Existing 3-36"RCP

Improve Debris Basin by :
- Increasing sediment storage
- Reconstructing outlet

Transition

Purchase flood easement

Concrete Line 3-8'2"X5'9" SPPC

Unlined Diversion B=40', H=6', Z=1:1

Concrete Line 3-12'10"X8'4" SPPC

Figure No. 3

KEOPU/HIENALOLI DRAINAGEWAY ALTERNATIVE

100-Year Level of Protection

Figure No. 4

WAIAHA DRAINAGEWAY
ALTERNATIVE

100-Year Level of Protection

Figure No. 5
KAUMALUMALU
DRAINAGEWAY ALTERNATIVE
100-Year Level of Protection

DAM SAFETY

At the request of DOWALD, an inventory and hazard analysis of existing dams and/or reservoirs was conducted in the area. This would aid them in their implementation of statewide dam safety regulations proposed in the Hawaii State Legislature.

There are two existing dams in the area, both of which are adjacent to the Waiaha Drainageway and are presently being used for livestock purposes. The Luawai Reservoir is at elevation 2,500 feet and the other unnamed dam at elevation 3,200 feet. The Luawai reservoir has a storage capacity of about 3 million gallons while the unnamed reservoir has less capacity. Both of these reservoirs have earth embankments of less than 5 feet.

Based on these embankment heights and cross sectional area, breach discharges in the event of a structural failure were calculated in accordance with the "Dam Breach Discharge Criteria" found in SCS National Engineering Manual Circular No. 1. In both cases the breach discharges were minimal and would not create any hazard downstream.

DRAINAGEWAY MAINTENANCE

As part of this study a field investigation was conducted to determine the existing condition of the Hienaloli, Keopu, Waiaha, Holualoa/Horseshoe Bend and Kaumalumalu drainageways and the required maintenance to alleviate flooding problems in the event of another storm. To do this, about 25 miles of drainageways were walked and the existing conditions were noted; specifically the extent of streambed erosion, type of debris and sediment, vegetation within bank and the extent of any visible floodplains from the 1982 storm. The maintenance required to alleviate imminent flooding problems from another storm was proposed in Appendix D.

INVESTIGATIVE PROCEDURES

Field Surveys

In order to accurately delineate the major drainageways and plot the stream cross sections, the most current topographic maps were used in this study along with aerial survey, surveyed cross sections and interviews with local people by SCS personnel and volunteer help from the Kona SWCD. The County of Hawaii Public Works Department surveyed all road crossings in the study area; noting the culvert sizes, locations and elevations with respect to the road.

The county also provided topographic maps of the area that were prepared from aerial photos flown in 1972 and 1973. These maps have contour intervals of 5 and 10 feet and a scale of 1" = 200'. In areas where there has been substantial changes in topography, the contours of the final maps have been revised to reflect this. Channel cross sections for the water surface profile computer program were obtained from these topographic maps. As a further refinement, the majority of the drainageways were walked and cross sections were surveyed by SCS and Kona SWCD volunteers and incorporated into the hydraulic analyses.

The locations of the major drainageways were determined from the topographic maps, field inspection, information from local residents at several public meetings and a helicopter survey of the damaged area just after the storm in February 1982. A total of seven drainageways were identified as having definite flow patterns and potential for causing the most damage.

Hydrologic Studies

Hydrologic analyses were based on SCS methodology found in Section 4, SCS National Engineering Handbook (NEH-4). A computer program titled "Project Formulation-Hydrology" (Technical Release 20) was used to compute peak discharges at all cross sections for the 10-year, 50-year, 100-year and 500-year frequency storms (Appendix C).

Runoff curve numbers used in the SCS hydrology method were estimated from soils and land use information and compared with previous hydrologic studies done in the area. Soils information was obtained from the 1973 **Survey of the Island of Hawaii, State of Hawaii**, published by the SCS in cooperation with the University of Hawaii Agricultural Experiment Station. Land use information was based on the **Draft Kona Regional Plan** prepared by the County of Hawaii Planning Department. Rainfall data was obtained from the National Weather Service, Technical Paper No. 43.

There are three active stream gages in the area: Right Branch Waiaha Stream near Holualoa (No. 16759200), Waiaha at Luawai (No. 16759300) and Keopu Stream near Kailua (No. 16759180). The former two are continuous recording gages with a period of record from 1961 to 1980; the latter is a crest gage station with a record period from 1965 to 1980. Frequency-discharge curves based on the Water Resources Council (WRC) guidelines for all three gages were compared to frequency-discharge curves as derived from the TR-20 output and curve numbers were adjusted so that peak discharges were compatible with the WRC estimates.

Hydraulic Analysis

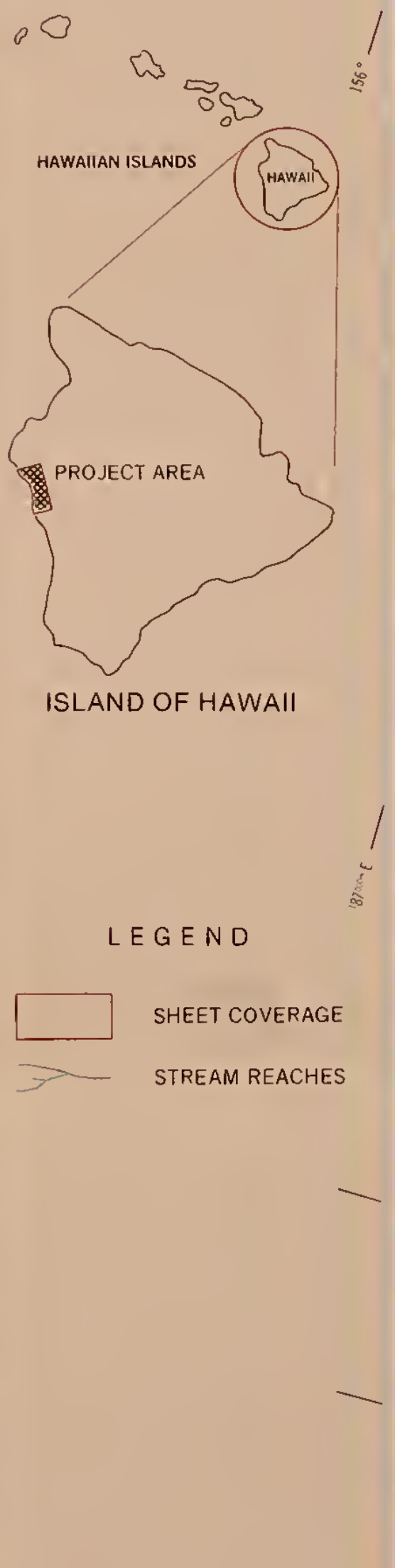
Channel cross section data taken from the topographic maps and surveyed cross sections were compiled for input in the Corps of Engineers' HEC-2 water surface profile computer program. Output data from this program were used to develop elevation-discharge and top width-discharge rating curves for each cross section. The elevation-discharge rating curves were used with the peak discharge information from the TR-20 output to obtain water surface elevations at each cross section for the 10-year, 50-year and 500-year events (Appendix C). These elevations were adjusted to conform to known high water marks from the February 1982 storm.

The top width-discharge curves were used with the peak discharge information again to derive the top width at each cross section for the respective storm events. The flood plains were then plotted on the flood hazard maps (Appendix A) based on the top widths and information from interviews with local residents.

APPENDIX A

U.S. DEPARTMENT OF AGRICULTURE

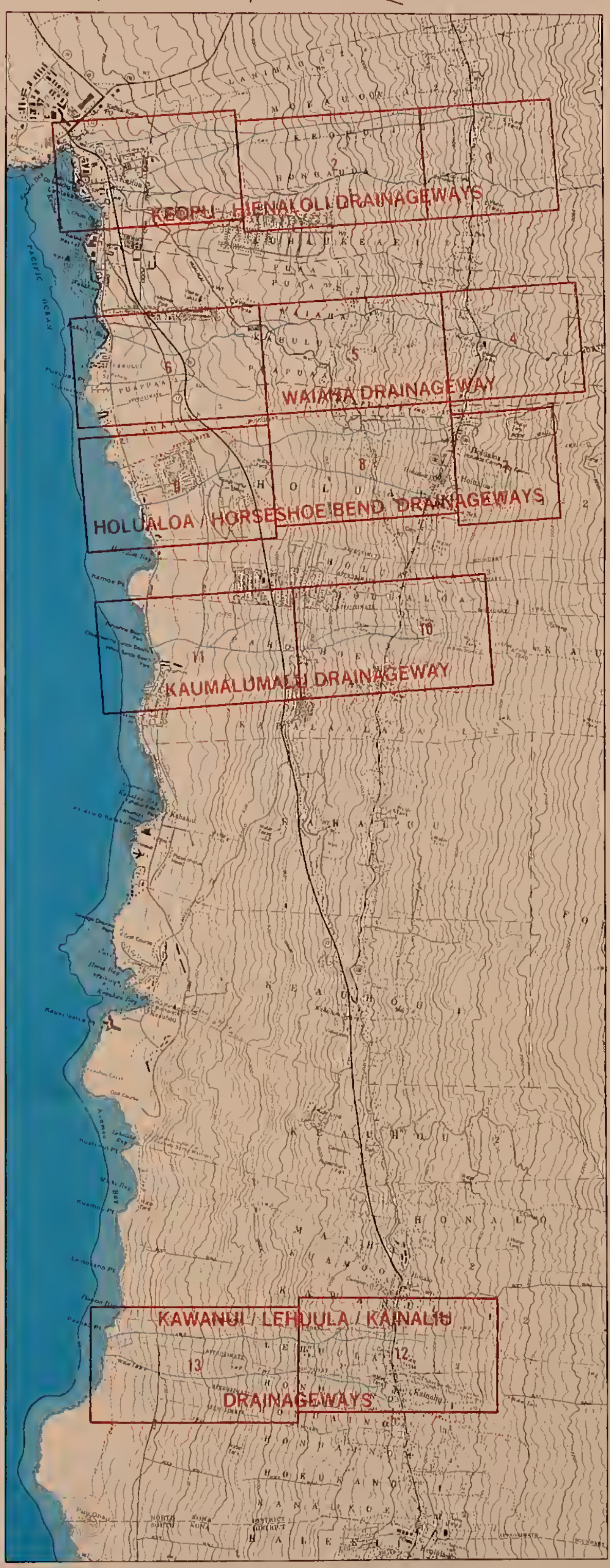
SOIL CONSERVATION SERVICE



LEGEND

SHEET COVERAGE

STREAM REACHES



FLOOD HAZARD STUDY AREA

VICINITY AND SHEET INDEX MAP

NORTH KONA DISTRICT, HAWAII

HAWAII COUNTY, HAWAII

5000 Feet 0 1 Mile

1000 Meters 0 1 Kilometer

APPROXIMATE SCALE

SOURCE: 1982 7.5 MINUTE TOPOGRAPHIC QUADRANGLES AND S.C.S. FIELD PERSONNEL

FEBRUARY 1984 4-R-38,503

USDA SCS FORT WORTH TEXAS 1984

KEOPU

HIENALOLI

DRAINAGEWAY

MAMALAHOA HIGHWAY

DRAINAGEWAY

Keopu Heights Subdivision

BM 16

2000
1900
1850
1800
1750
1700
1650
1600
1550
1500
1450
1400
1350
1300
1250
1200

KE 53 KE 52 KE 51 KE 50 KE 49 KE 48 KE 39 KE 38 KE 37 KE 36 KE 47 KE 46 KE 22 05 KE 22 06 KE 22 04 KE 42

HI 38 HI 37 HI 36 HI 35 HI 34 HI 32 HI 33 HI 31 HI 30 HI 29 HI 28

100 Year Flood Hazard Area
500 Year Flood Hazard Area
W 12 Cross Section Location
Stream Channel

XBM-1 Elevation Reference Marks

Limits of Flooding May Vary From Actual Ground Location

Contour Data Derived From R.M. Towill Corp., Honolulu Hawaii

Contour Interval Change From 5' to 10' Intervals After 250' Elevation

U.S.G.S. Ortho Photography 1977

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH KONA
FLOOD PLAIN MANAGEMENT STUDY
NORTH KONA DISTRICT, HAWAII

SHEET 1 OF 13

FLOOD HAZARD AREA

KEOPU/HIENALOLI DRAINAGEWAYS

FEB 1984 4-R-38509

100 Year Flood Hazard Area
500 Year Flood Hazard Area
Cross Section Location
Stream Channel

XBM-1 Elevation Reference Marks

Limits of Flooding May Vary From Actual Ground Location

Contour Data Derived From R.M. Towill Corp., Honolulu Hawaii

Contour Interval Change From 5' to 10' Intervals After 250' Elevation

U.S.G.S. Ortho Photography 1977

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

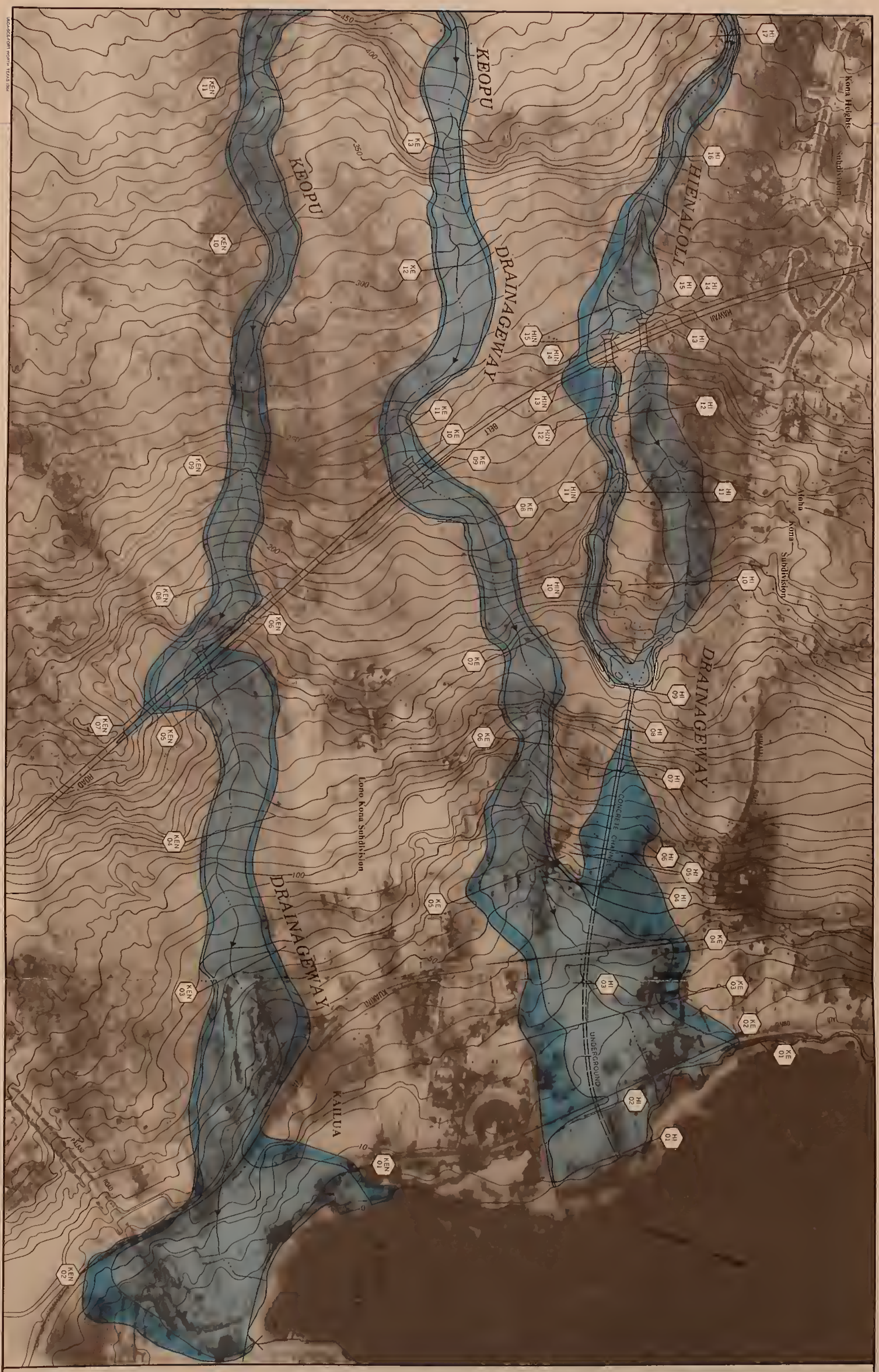
SHEET 2 OF 13

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH KONA
FLOOD PLAIN MANAGEMENT STUDY
NORTH KONA DISTRICT, HAWAII

FLOOD HAZARD AREA

KEOPU/HIENALOLI DRAINAGEWAYS

FEB 1984 4-R-38509



100 Year Flood Hazard Area
500 Year Flood Hazard Area
W 12 Cross Section Location
Stream Channel

X BM-1 Elevation Reference Marks

Limits of Flooding May Vary From Actual Ground Location

Contour Data Derived From R.M. Towill Corp., Honolulu Hawaii

Contour Interval Change From 5' to 10' Intervals After 250' Elevation

U.S.G.S. Ortho Photography 1977

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH KONA
FLOOD PLAIN MANAGEMENT STUDY
NORTH KONA DISTRICT, HAWAII

SHEET 3 OF 13

FLOOD HAZARD AREA

KEOPU/HIENALOLI DRAINAGEWAYS

FEB 1984 4-R-38509

100 Year Flood Hazard Area

500 Year Flood Hazard Area

W 12 Cross Section Location

Stream Channel

X BM-1 Elevation Reference Marks

Limits of Flooding May Vary From Actual Ground Location

Contour Data Derived From R.M. Towill Corp., Honolulu Hawaii

Contour Interval Change From 5' to 10' Intervals After 250' Elevation

U.S.G.S. Ortho Photography 1977

SCALE 0 400 800 FEET

0 100 200 METERS

APPROXIMATE

SHEET 4 OF 13

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

NORTH KONA

FLOOD PLAIN MANAGEMENT STUDY

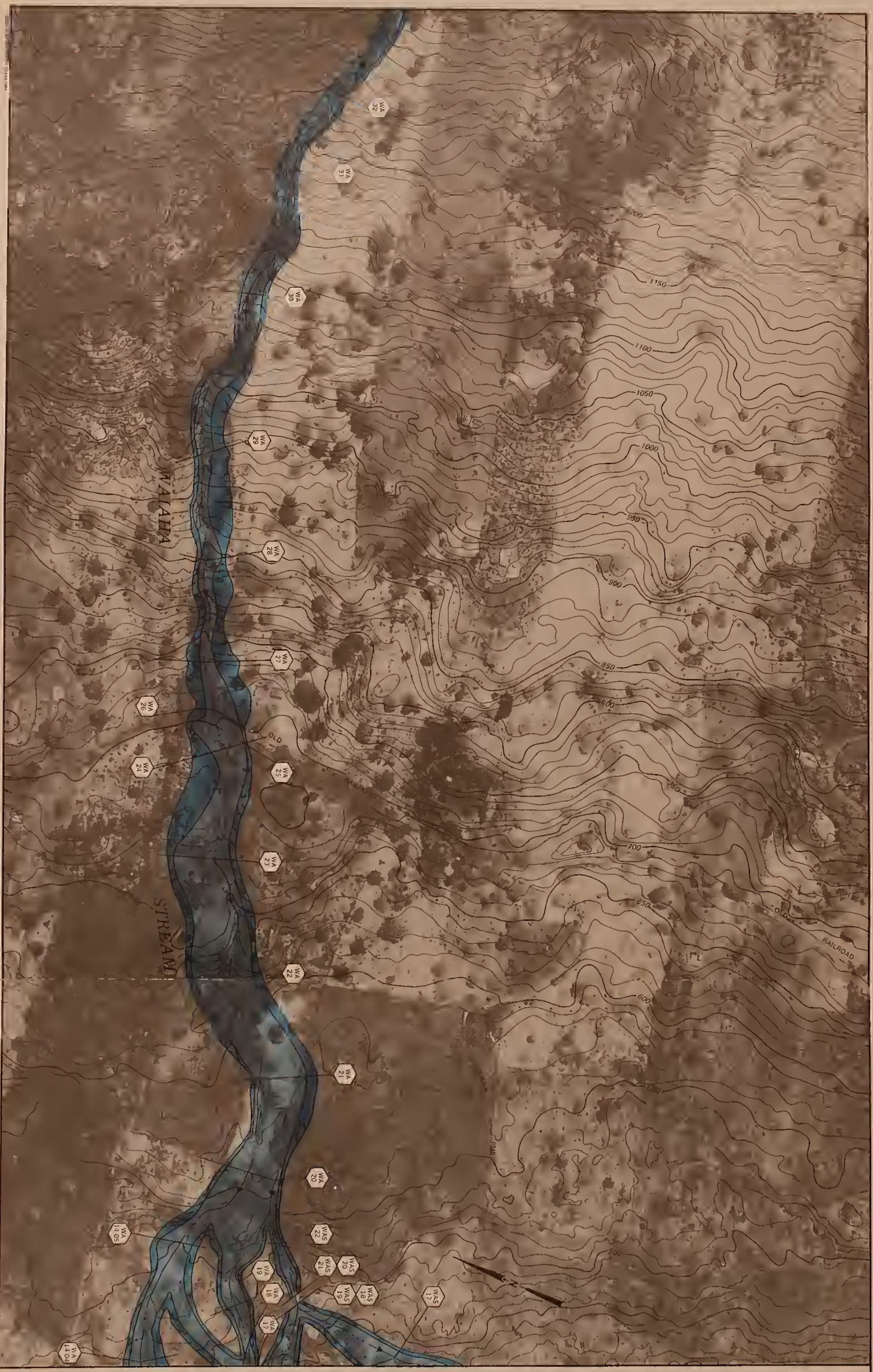
NORTH KONA DISTRICT, HAWAII

FLOOD HAZARD AREA

WAIAHA DRAINAGEWAY

FEB 1984 4-R-38509

USDA SCS-FORT WORTH TEXAS 1984



100 Year Flood Hazard Area

500 Year Flood Hazard Area

W 12 Cross Section Location

Stream Channel

X BM-1 Elevation Reference Marks

Limits of Flooding May Vary From Actual Ground Location

Contour Data Derived From R.M. Towill Corp., Honolulu Hawaii

Contour Interval Change From 5' to 10' Intervals After 250' Elevation

U.S.G.S. Ortho Photography 1977

SCALE 0 400 800 FEET

0 100 200 METERS

APPROXIMATE

SHEET 5 OF 13

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

NORTH KONA

FLOOD PLAIN MANAGEMENT STUDY

NORTH KONA DISTRICT, HAWAII

FLOOD HAZARD AREA

WAIAHA DRAINAGEWAY

FEB 1984 4-R 38509

100 Year Flood Hazard Area
500 Year Flood Hazard Area
Cross Section Location
Stream Channel

X BM-1 Elevation Reference Marks

Limits of Flooding May Vary From Actual Ground Location

Contour Data Derived From R.M. Towill Corp., Honolulu Hawaii

Contour Interval Change From 5' to 10' Intervals After 250' Elevation

U.S.G.S. Ortho Photography 1977

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH KONA
FLOOD PLAIN MANAGEMENT STUDY
NORTH KONA DISTRICT, HAWAII

FLOOD HAZARD AREA

WAIAHA DRAINAGEWAY

SHEET 6 OF 13

FEB 1984 4-R-38509

USDA SCS FORT WORTH TEXAS 1984

100 Year Flood Hazard Area
500 Year Flood Hazard Area
W 12 Cross Section Location
Stream Channel

X BM-1 Elevation Reference Marks

Limits of Flooding May Vary From Actual Ground Location

Contour Data Derived From R.M. Towill Corp., Honolulu Hawaii

Contour Interval Change From 5' to 10' Intervals After 250' Elevation

U.S.G.S. Ortho Photography 1977

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

SHEET 7 OF 13

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH KONA
FLOOD PLAIN MANAGEMENT STUDY
NORTH KONA DISTRICT, HAWAII

FLOOD HAZARD AREA

HOLUALOA / HORSESHOE BEND DRAINAGEWAYS

FEB 1984 4-R-38509

100 Year Flood Hazard Area
500 Year Flood Hazard Area
W-L2 Cross Section Location
Stream Channel

X BM-1 Elevation Reference Marks

Limits of Flooding May Vary From Actual Ground Location

Contour Data Derived From R.M. Towill Corp., Honolulu Hawaii

Contour Interval Change From 5' to 10' Intervals After 250' Elevation

U.S.G.S. Ortho Photography 1977

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

SHEET 8 OF 13

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH KONA
FLOOD PLAIN MANAGEMENT STUDY
NORTH KONA DISTRICT, HAWAII

FLOOD HAZARD AREA

HOLUALOA / HORSESHOE BEND DRAINAGEWAYS

FEB 1984 4-R-38509

100 Year Flood Hazard Area
500 Year Flood Hazard Area
W 12 Cross Section Location
Stream Channel

X BM-1 Elevation Reference Marks

Limits of Flooding May Vary From Actual Ground Location

Contour Data Derived From R.M. Towill Corp., Honolulu Hawaii

Contour Interval Change From 5' to 10' Intervals After 250' Elevation

U.S.G.S. Ortho Photography 1977

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NORTH KONA
FLOOD PLAIN MANAGEMENT STUDY
NORTH KONA DISTRICT, HAWAII

FLOOD HAZARD AREA

HOLUALOA / HORSESHOE BEND DRAINAGEWAYS

SHEET 9 OF 13

FEB 1984 4-R-38509

100 Year Flood Hazard Area
500 Year Flood Hazard Area
W 12 Cross Section Location
Stream Channel

X BM-1 Elevation Reference Marks

Limits of Flooding May Vary From Actual Ground Location

Contour Data Derived From R.M. Towill Corp., Honolulu Hawaii

Contour Interval Change From 5' to 10' Intervals After 250' Elevation

U.S.G.S. Ortho Photography 1977

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

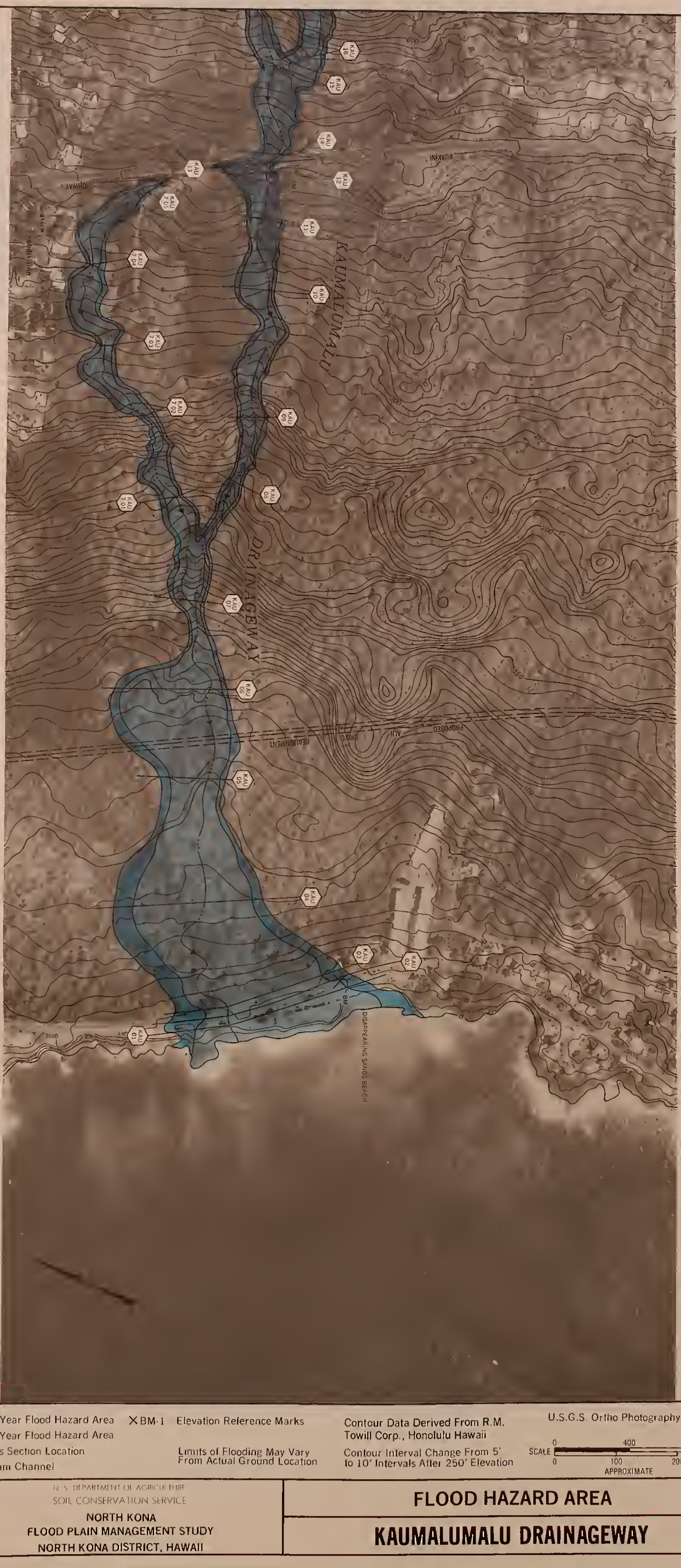
SHEET 10 OF 13

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH KONA
FLOOD PLAIN MANAGEMENT STUDY
NORTH KONA DISTRICT, HAWAII

FLOOD HAZARD AREA

KAUMALUMALU DRAINAGEWAY

FEB 1984 4-R-38509



100 Year Flood Hazard Area

500 Year Flood Hazard Area

W 1.2 Cross Section Location

Stream Channel

X BM-1 Elevation Reference Marks

Limits of Flooding May Vary From Actual Ground Location

Contour Data Derived From R.M. Towill Corp., Honolulu Hawaii

Contour Interval Change From 5' to 10' Intervals After 250' Elevation

U.S.G.S. Ortho Photography 1977

SCALE 0 400 800 FEET

0 100 200 METERS

APPROXIMATE

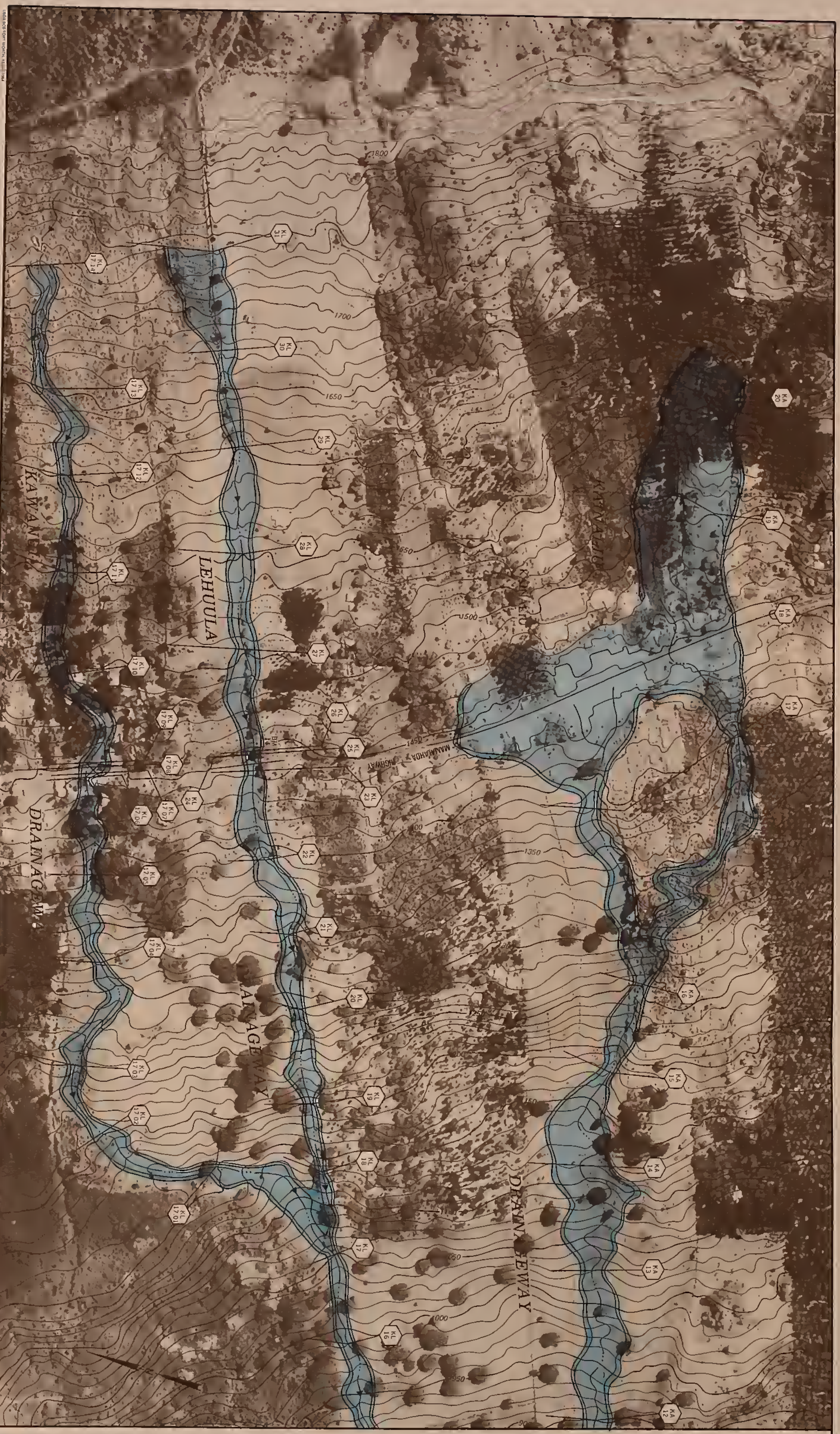
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH KONA
FLOOD PLAIN MANAGEMENT STUDY
NORTH KONA DISTRICT, HAWAII

FLOOD HAZARD AREA

KAUMALUMALU DRAINAGEWAY

SHEET 11 OF 13

FEB 1984 4-R-38509



100 Year Flood Hazard Area

500 Year Flood Hazard Area

W 12 Cross Section Location

Stream Channel

X BM-1 Elevation Reference Marks

Limits of Flooding May Vary From Actual Ground Location

Contour Data Derived From R.M. Towill Corp., Honolulu Hawaii

Contour Interval Change From 5' to 10' Intervals After 250' Elevation

U.S.G.S. Ortho Photography 1977

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

NORTH KONA
FLOOD PLAIN MANAGEMENT STUDY
NORTH KONA DISTRICT, HAWAII

FLOOD HAZARD AREA

KAWANUI / LEHUULA / KAINALIU DRAINAGEWAYS

SHEET 12 OF 13

FEB 1984 4-R-38509

KAWANUI-LEHUULA DRAINAGEWAY

KAINALIU DRAINAGEWAY

PAAOAO BAY

100 Year Flood Hazard Area
500 Year Flood Hazard Area
Cross Section Location
Stream Channel

×BM-1 Elevation Reference Marks

Limits of Flooding May Vary From Actual Ground Location

Contour Data Derived From R.M. Towill Corp., Honolulu Hawaii

Contour Interval Change From 5' to 10' Intervals After 250' Elevation

U.S.G.S. Ortho Photography 1977

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH KONA
FLOOD PLAIN MANAGEMENT STUDY
NORTH KONA DISTRICT, HAWAII

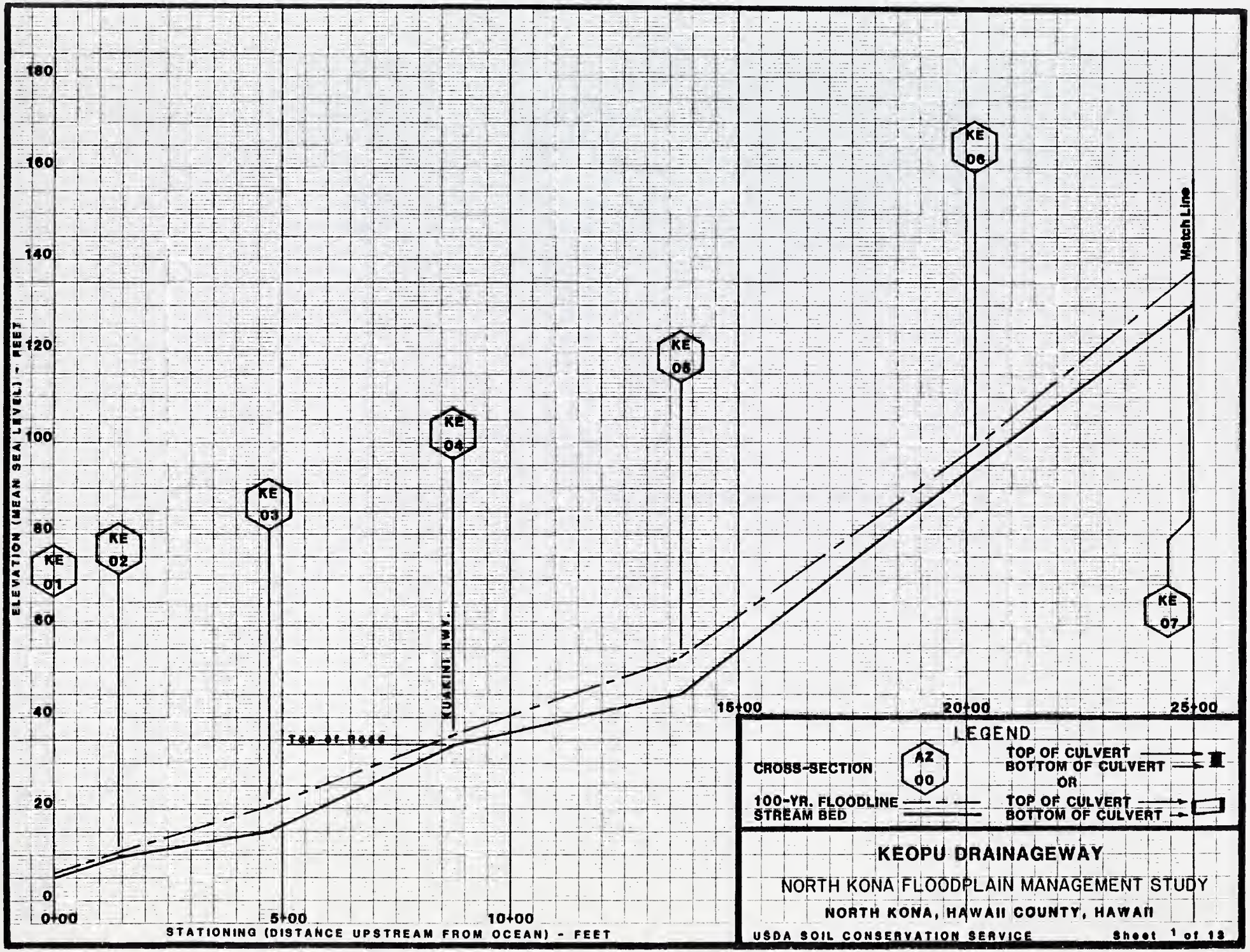
FLOOD HAZARD AREA

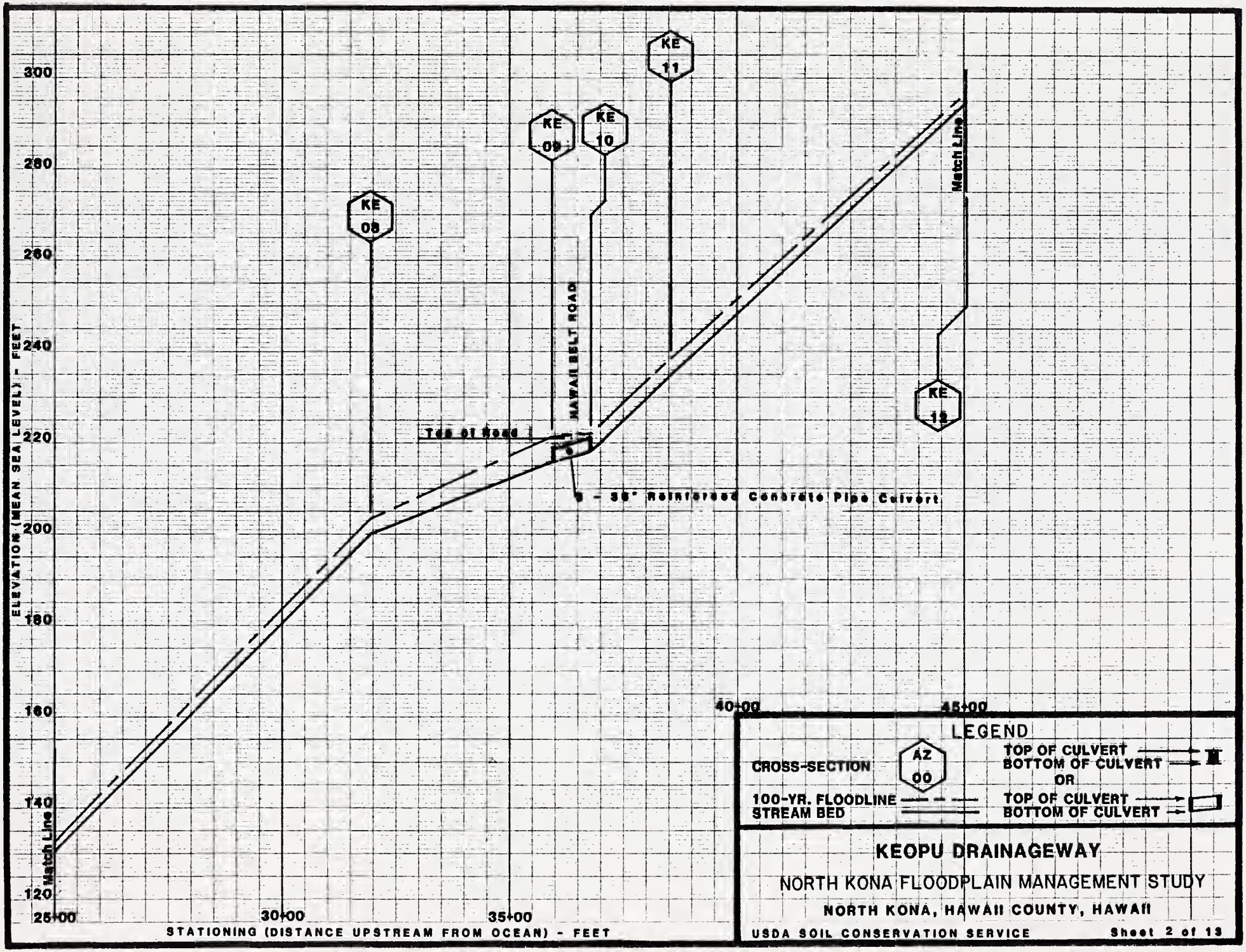
KAWANUI / LEHUULA / KAINALIU DRAINAGEWAYS

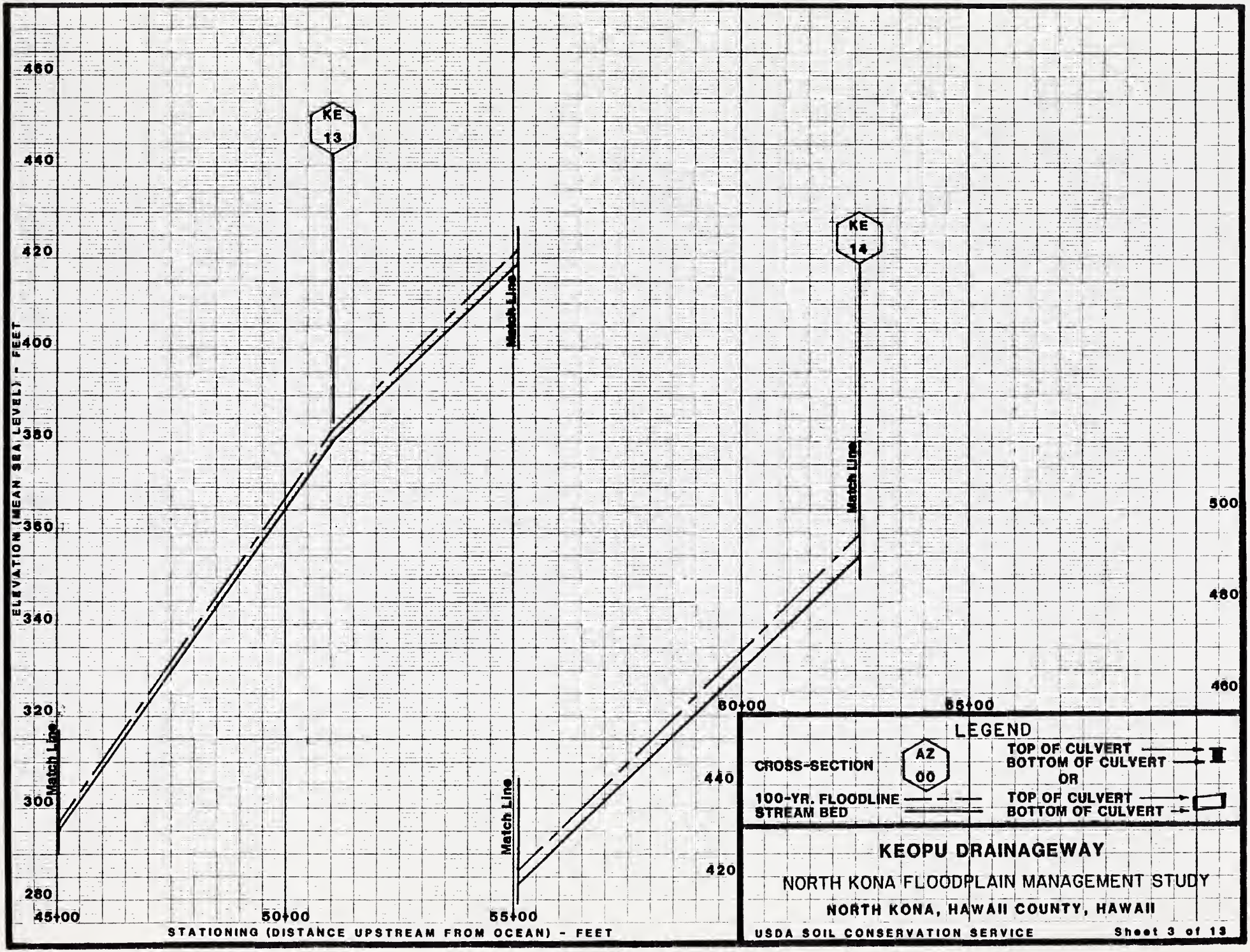
SHEET 13 OF 13

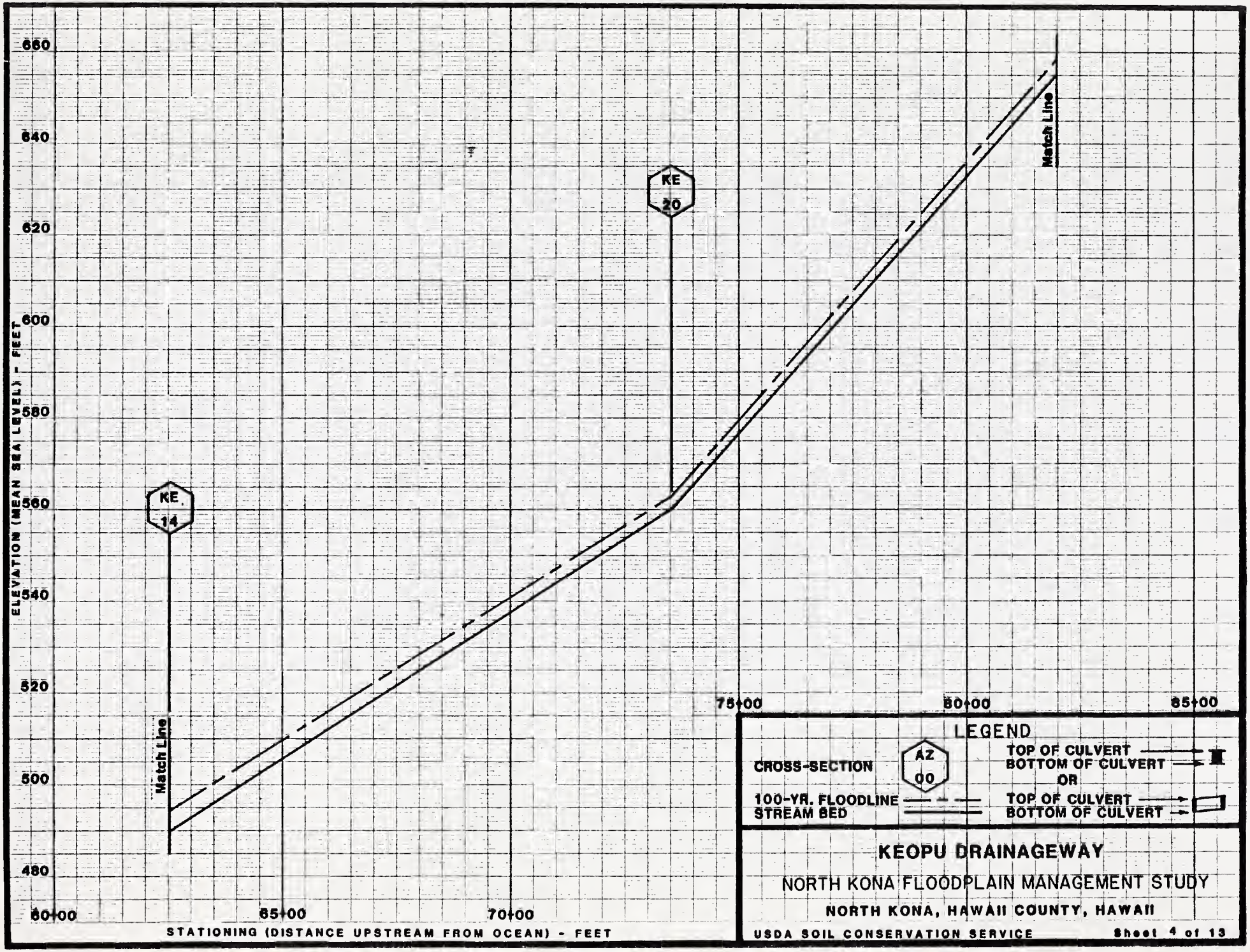
FEB 1984 4-R-38509

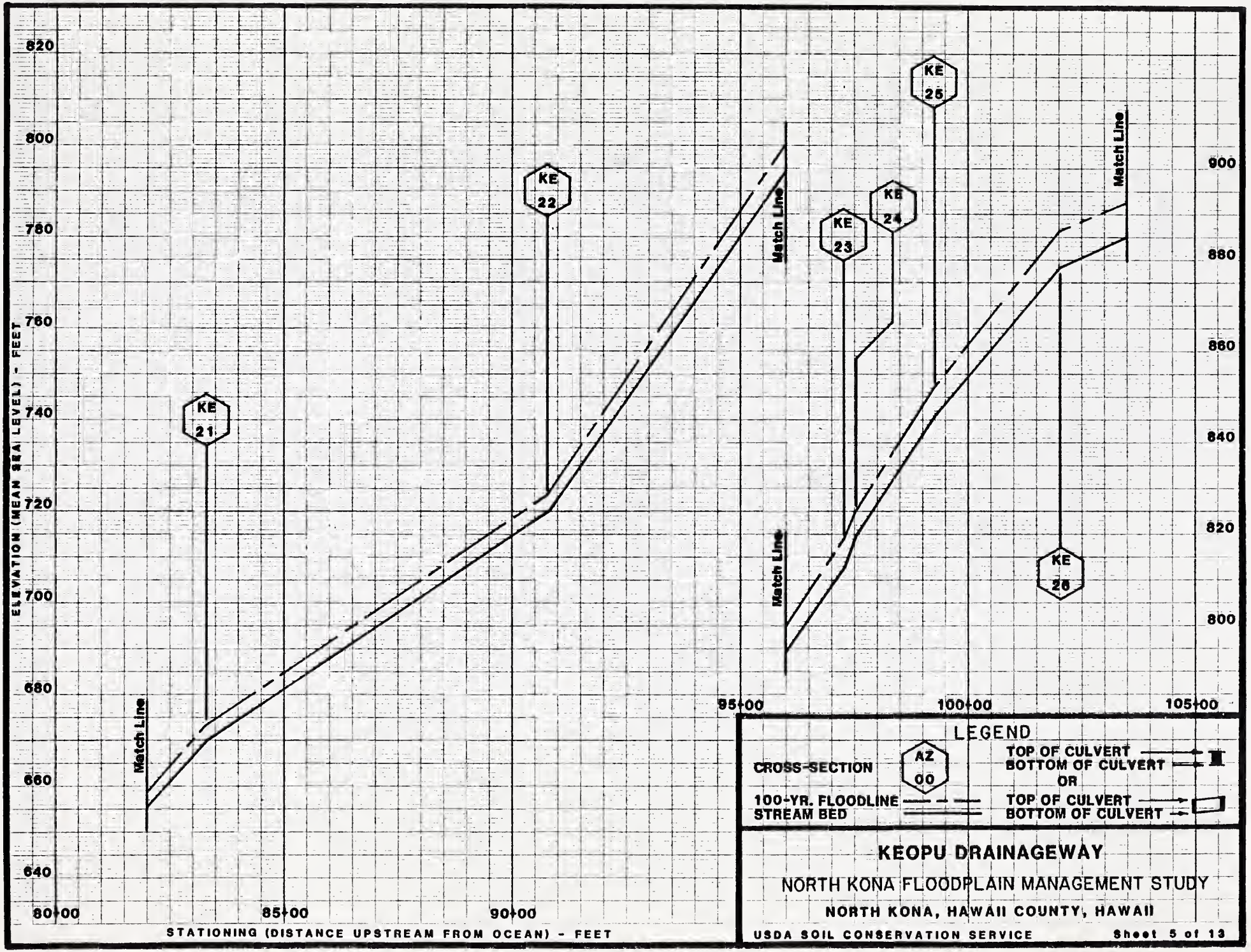
APPENDIX B


ELEVATION (MEAN SEA LEVEL) - FEET
180
160
140
120
100
80
60
40
20
0
0+00
5+00
10+00
15+00
20+00
25+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
KE 01
KE 02
KE 03
KE 04
KE 05
KE 06
KE 07
KUAKINI HWY.
Top of Road
Match Line
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KEOPU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 1 of 13


KE 11
KE 09
KE 10
KE 08
KE 12
Match Line
HAWAIIBELT ROAD
Top of Road
3 - 36" Reinforced Concrete Pipe Culvert
ELEVATION (MEAN SEA LEVEL) - FEET
300
280
260
240
220
200
180
160
140
120
Match Line
25+00
30+00
35+00
40+00
45+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KEOPU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 2 of 13


460
440
420
400
380
360
340
320
300
280
ELEVATION (MEAN SEA LEVEL) - FEET
KE 13
KE 14
Match Line
Match Line
Match Line
Match Line
500
480
460
440
420
45+00
50+00
55+00
60+00
65+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KEOPU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 3 of 13


660
640
620
600
580
560
540
520
500
480
ELEVATION (MEAN SEA LEVEL) - FEET
KE 14
KE 20
Match Line
Match Line
60+00
65+00
70+00
75+00
80+00
85+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KEOPU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 4 of 13

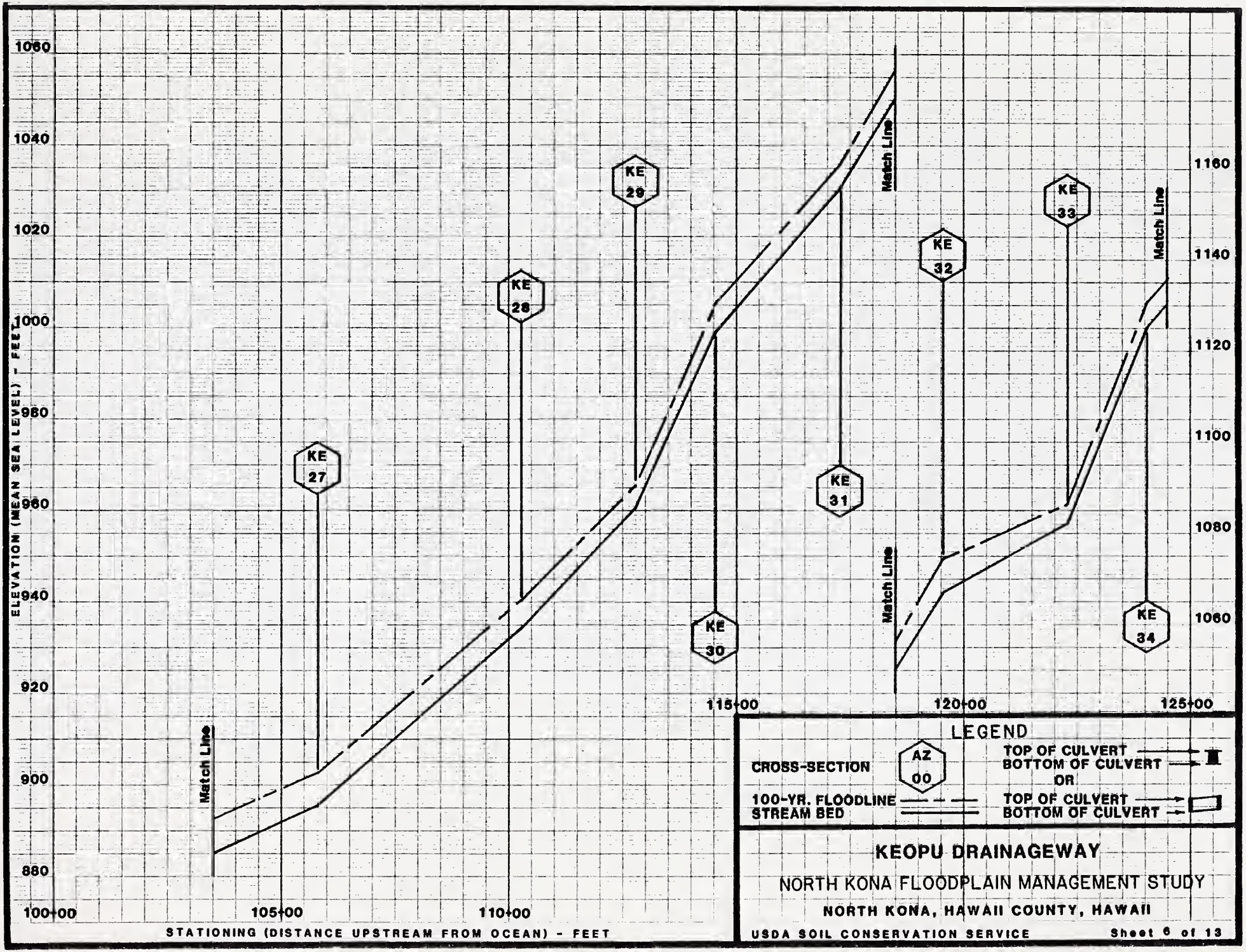


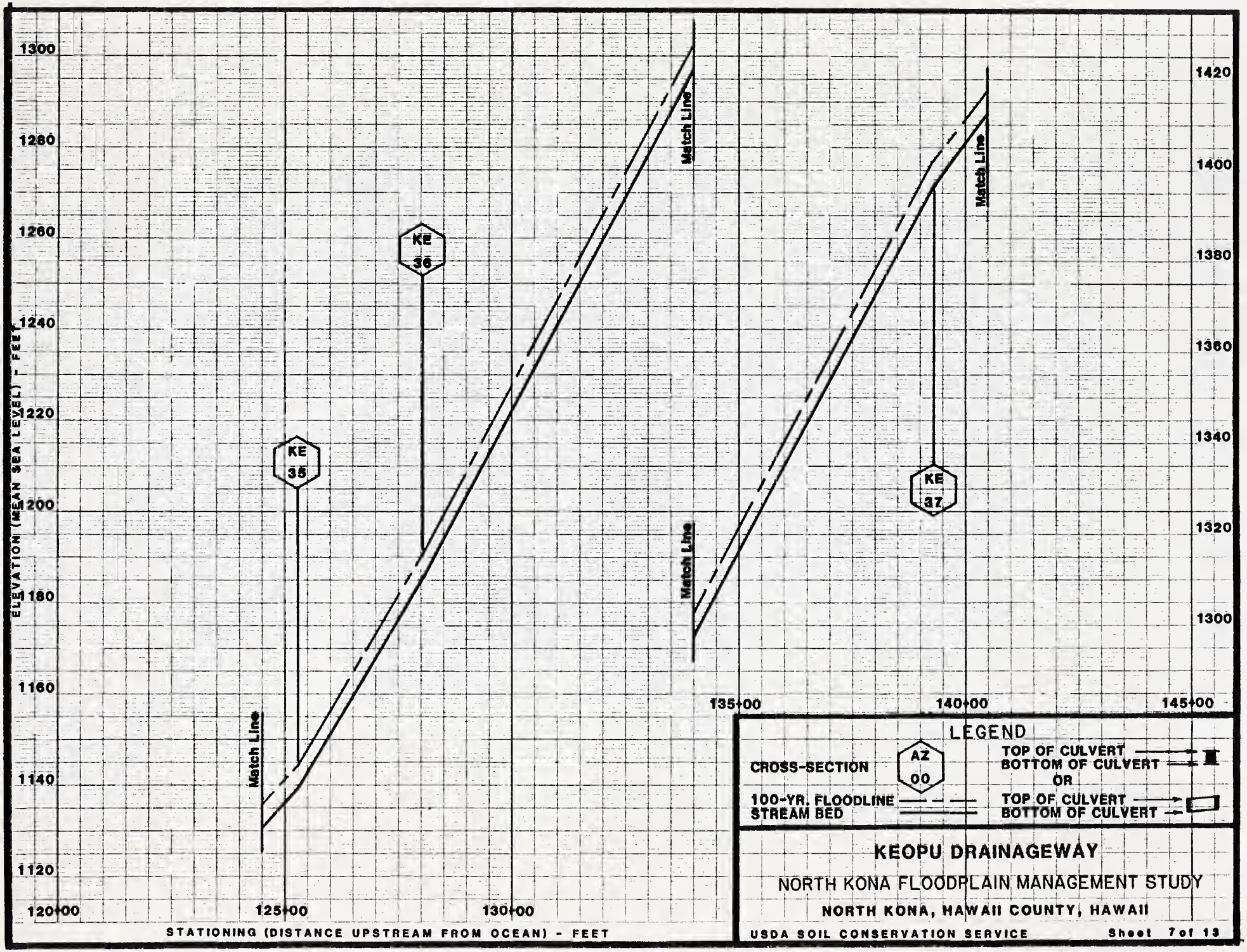
KEOPU DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


1060
1040
1020
1000
980
960
940
920
900
880
ELEVATION (MEAN SEA LEVEL) - FEET
1160
1140
1120
1100
1080
1060
100+00
105+00
110+00
115+00
120+00
125+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
KE 27
KE 28
KE 29
KE 30
KE 31
KE 32
KE 33
KE 34
Match Line
Match Line
Match Line
Match Line
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KEOPU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 6 of 13

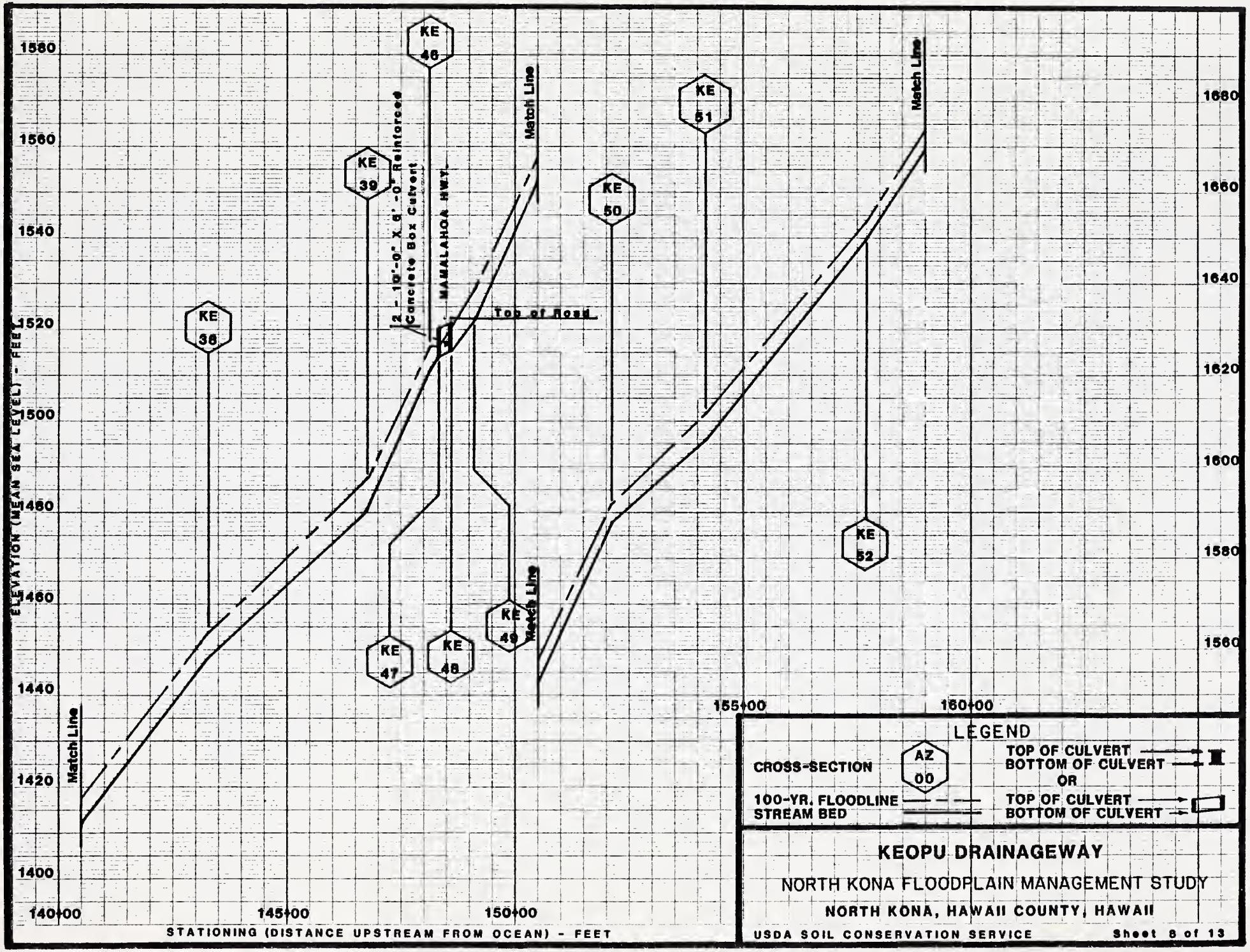


KEOPU DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

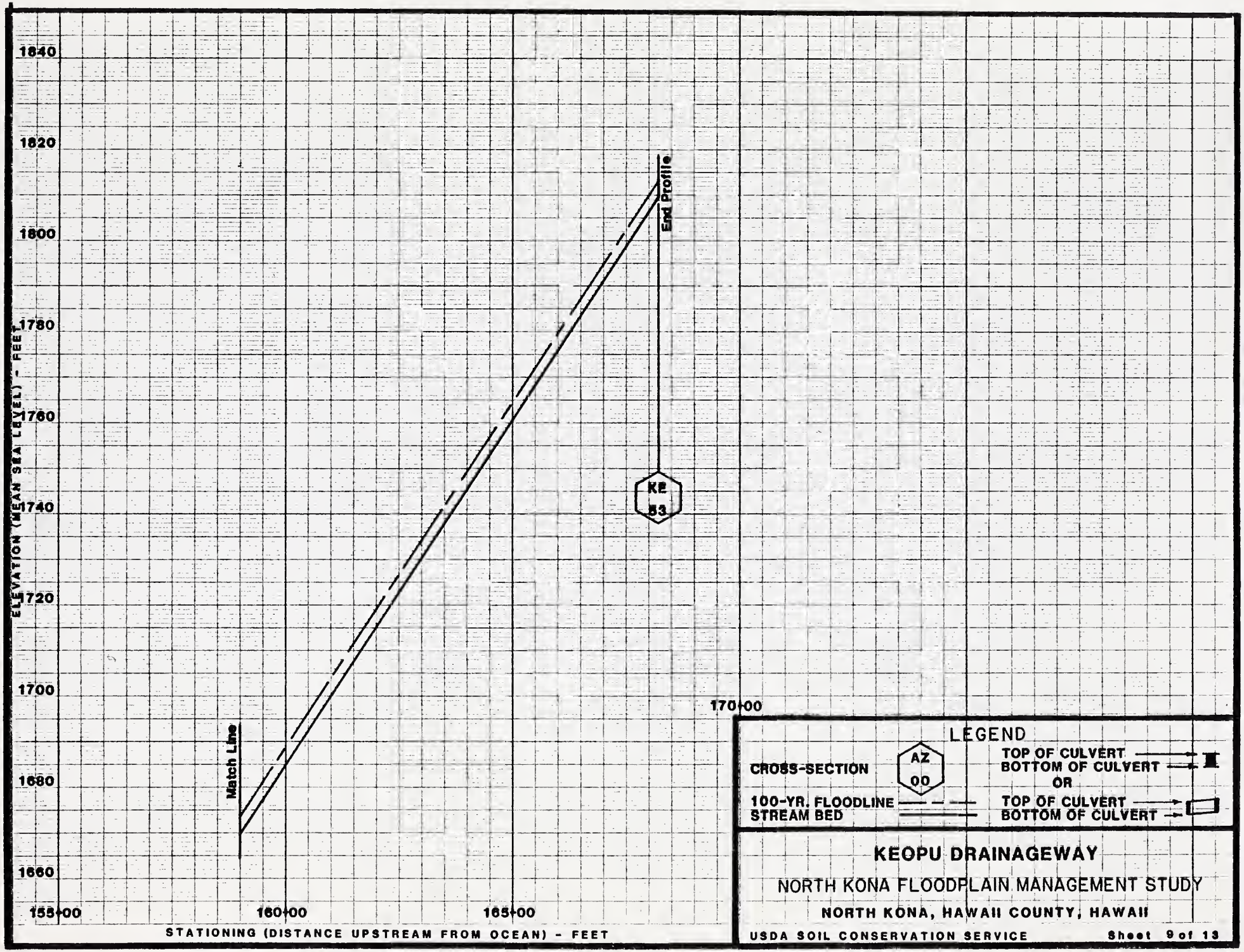


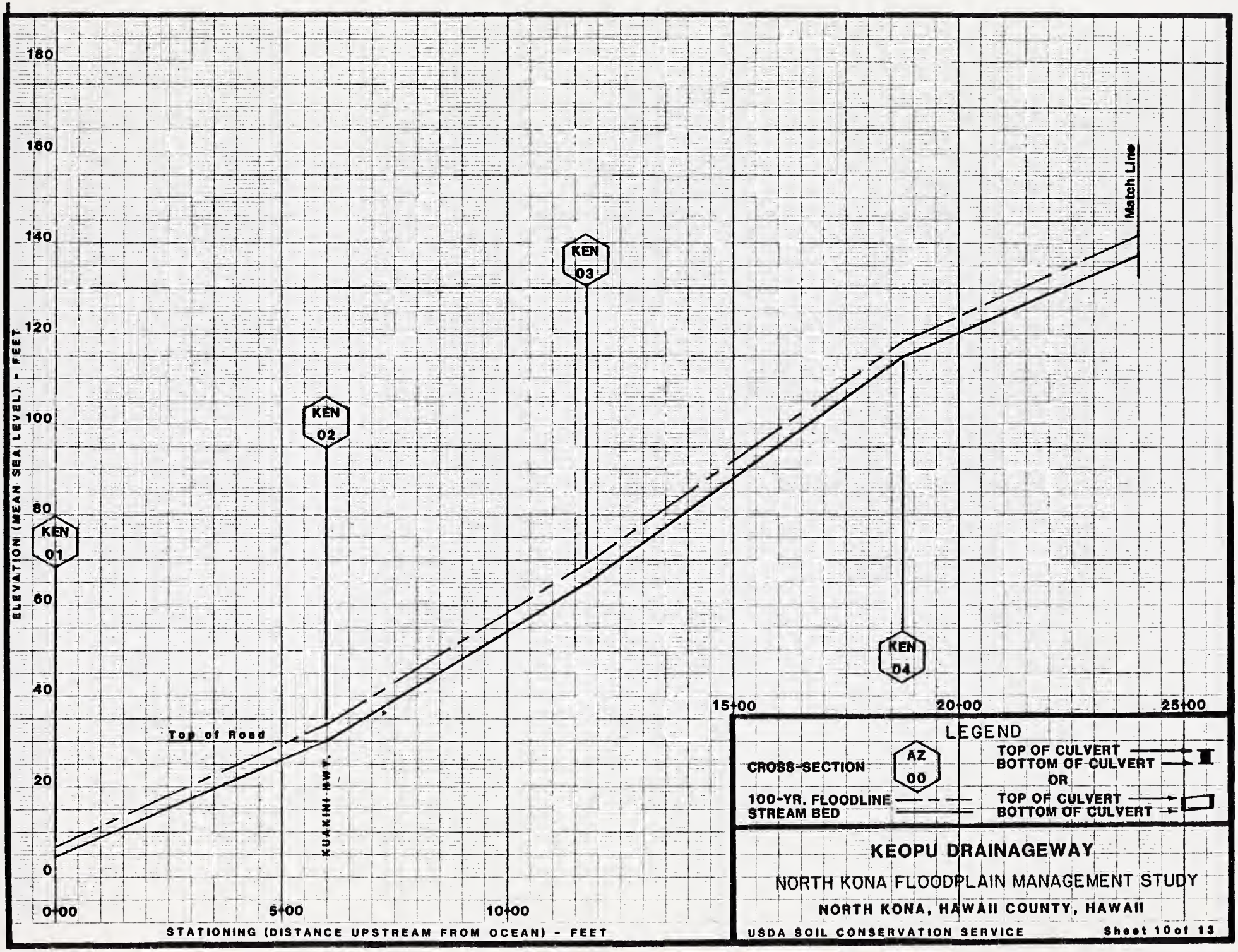
KEOPU DRAINAGEWAY

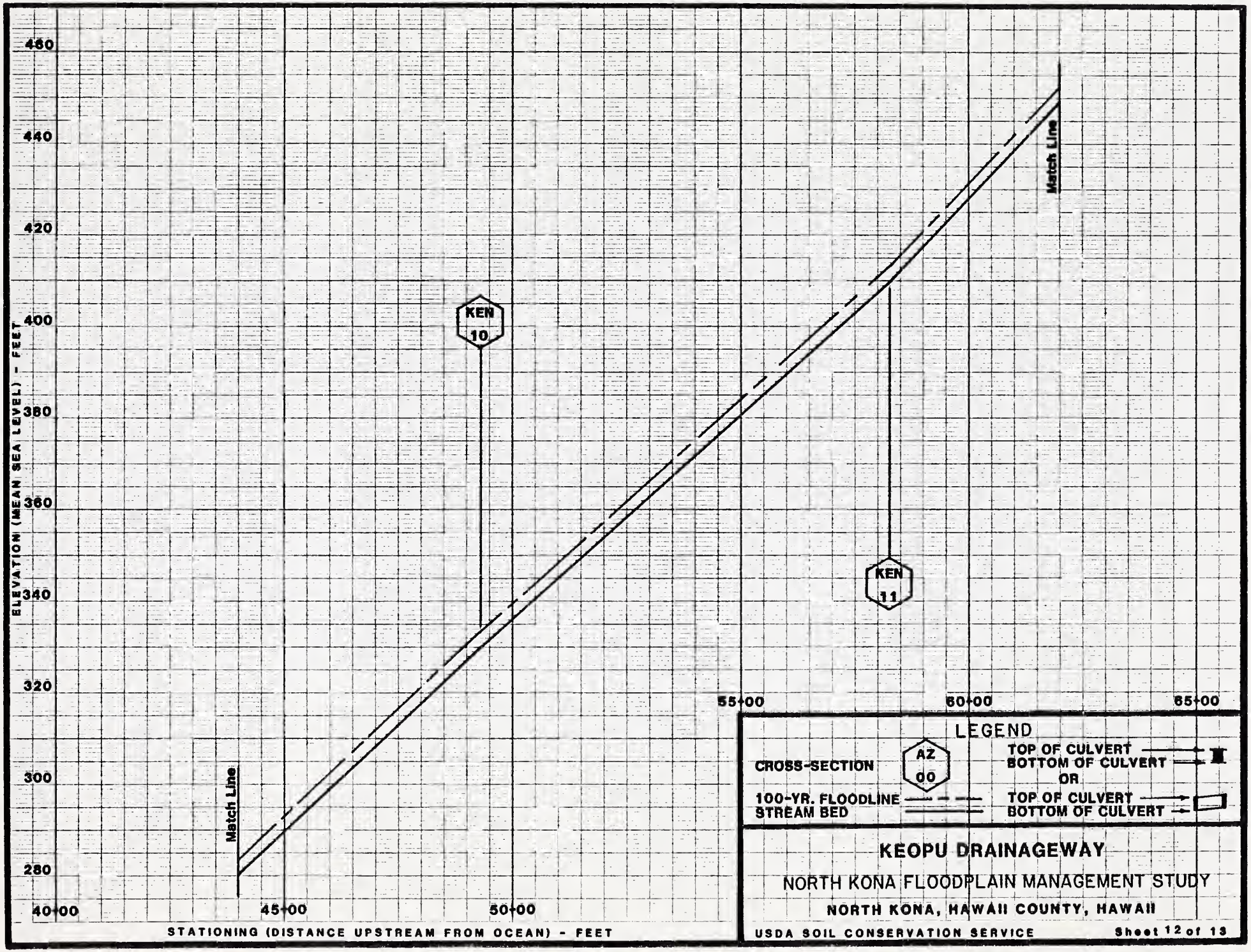
NORTH KONA FLOODPLAIN MANAGEMENT STUDY

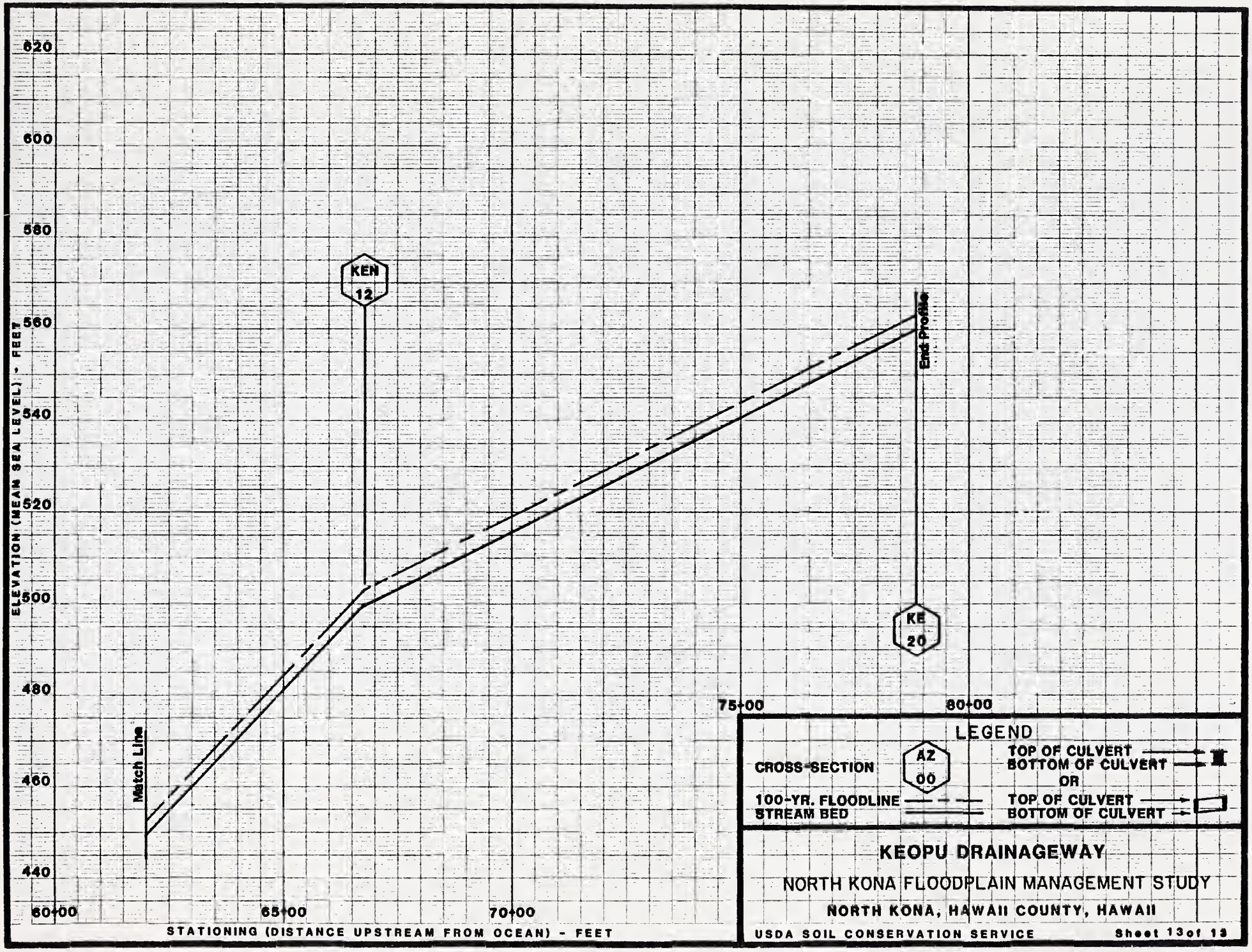
NORTH KONA, HAWAII COUNTY, HAWAII

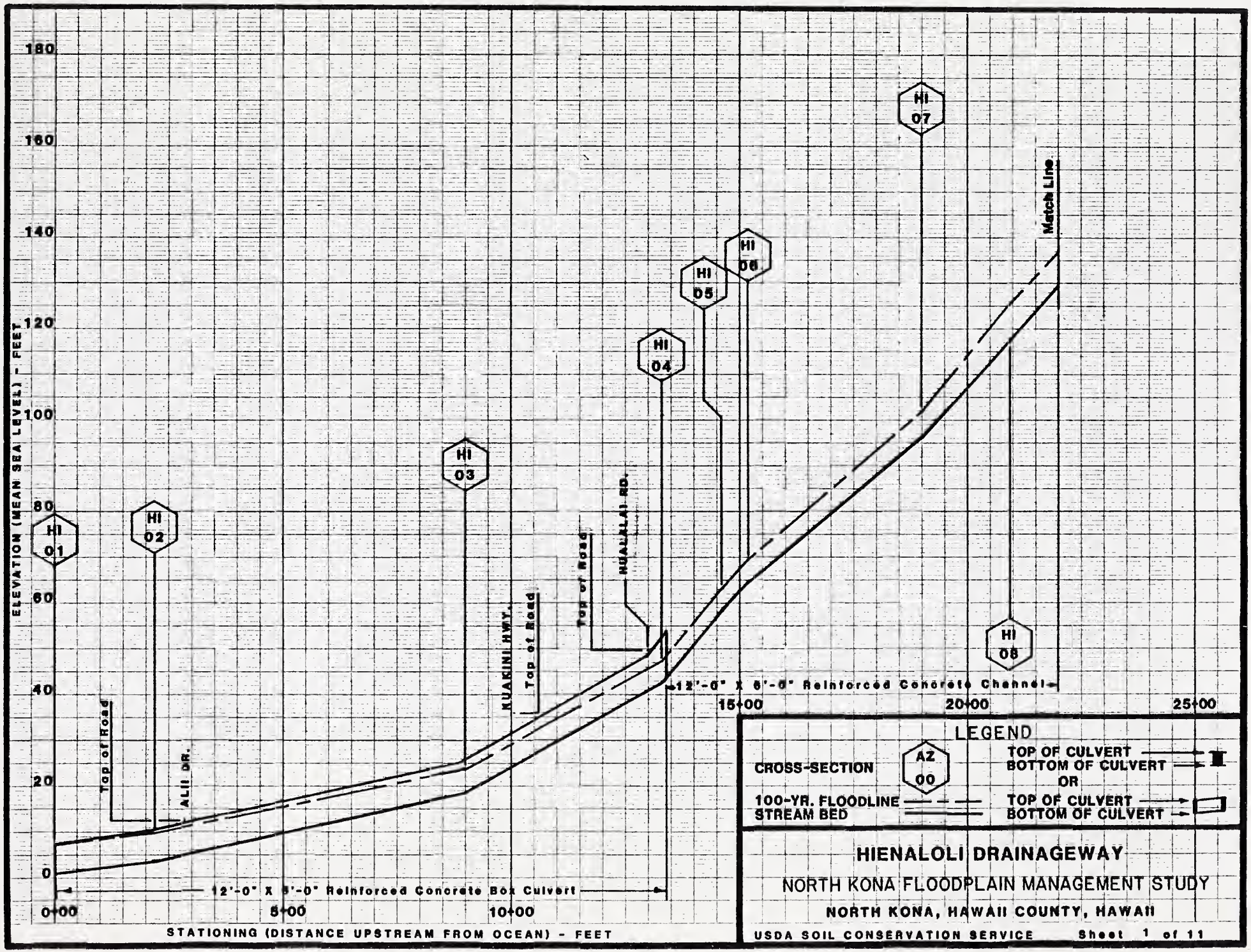
USDA SOIL CONSERVATION SERVICE

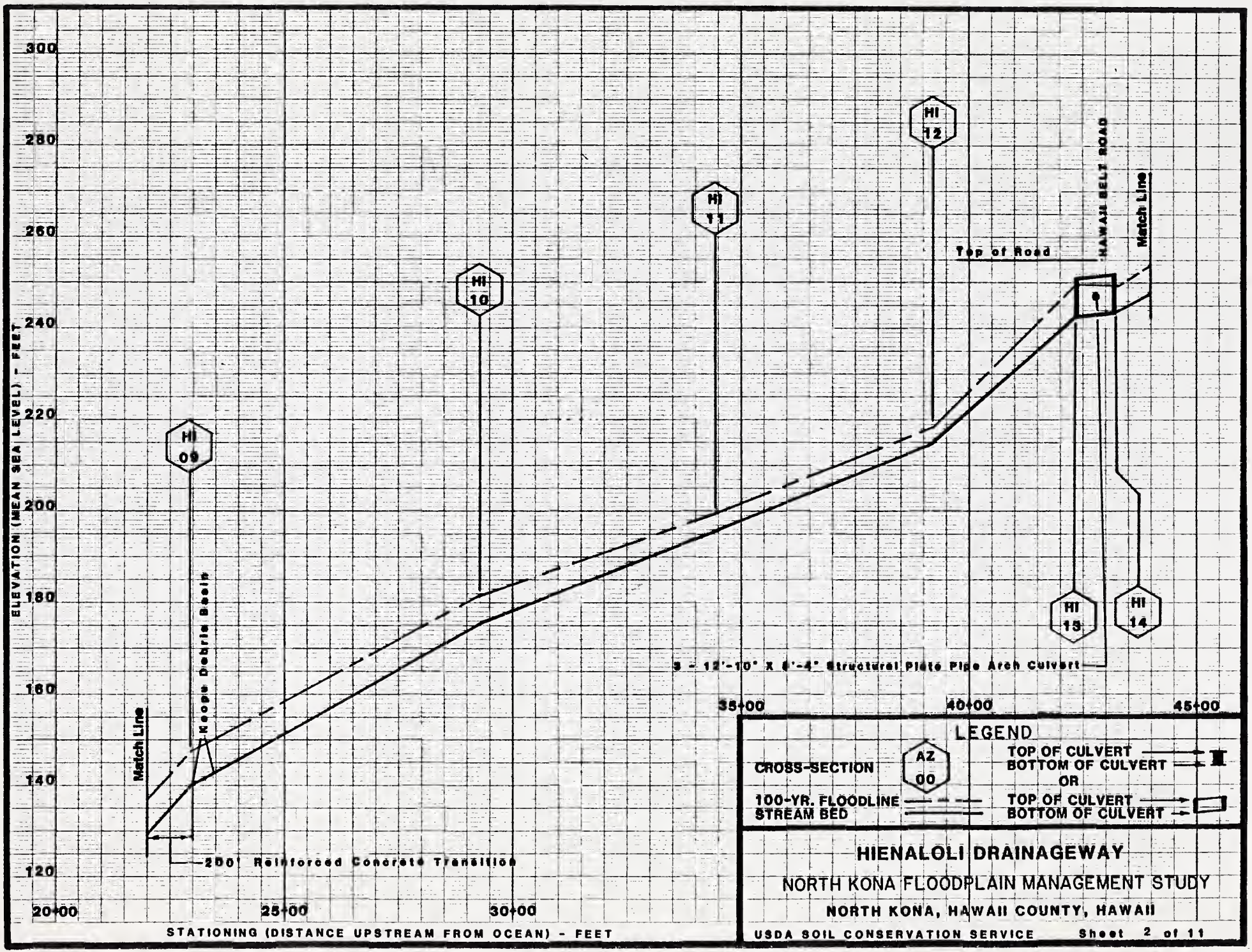

1840
1820
1800
1780
1760
1740
1720
1700
1680
1660
ELEVATION (MEAN SEA LEVEL) - FEET
End Profile
KE
53
Match Line
155+00
160+00
165+00
170+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KEOPU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 9 of 13


180
160
140
120
100
80
60
40
20
0
ELEVATION (MEAN SEA LEVEL) - FEET
KEN 01
KEN 02
KEN 03
KEN 04
Match Line
Top of Road
KUAKINI HWY.
0+00
5+00
10+00
15+00
20+00
25+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KEOPU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 10 of 13


460
440
420
400
380
360
340
320
300
280
ELEVATION (MEAN SEA LEVEL) - FEET
40+00
45+00
50+00
55+00
60+00
65+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
KEN 10
KEN 11
Match Line
Match Line
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KEOPU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 12 of 13


620
600
580
560
540
520
500
480
460
440
ELEVATION (MEAN SEA LEVEL) - FEET
KEN
12
KE
20
End Profile
Match Line
60+00
65+00
70+00
75+00
80+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KEOPU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 13 of 13


ELEVATION (MEAN SEA LEVEL) - FEET
180
160
140
120
100
80
60
40
20
0
HI 01
HI 02
HI 03
HI 04
HI 05
HI 06
HI 07
HI 08
Match Line
Top of Road
ALII DR.
KUAKINI HWY.
Top of Road
Top of Road
HUALALAI RD.
12'-0" X 5'-0" Reinforced Concrete Box Culvert
12'-0" X 5'-0" Reinforced Concrete Channel
0+00
5+00
10+00
15+00
20+00
25+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
HIENALOLI DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 1 of 11

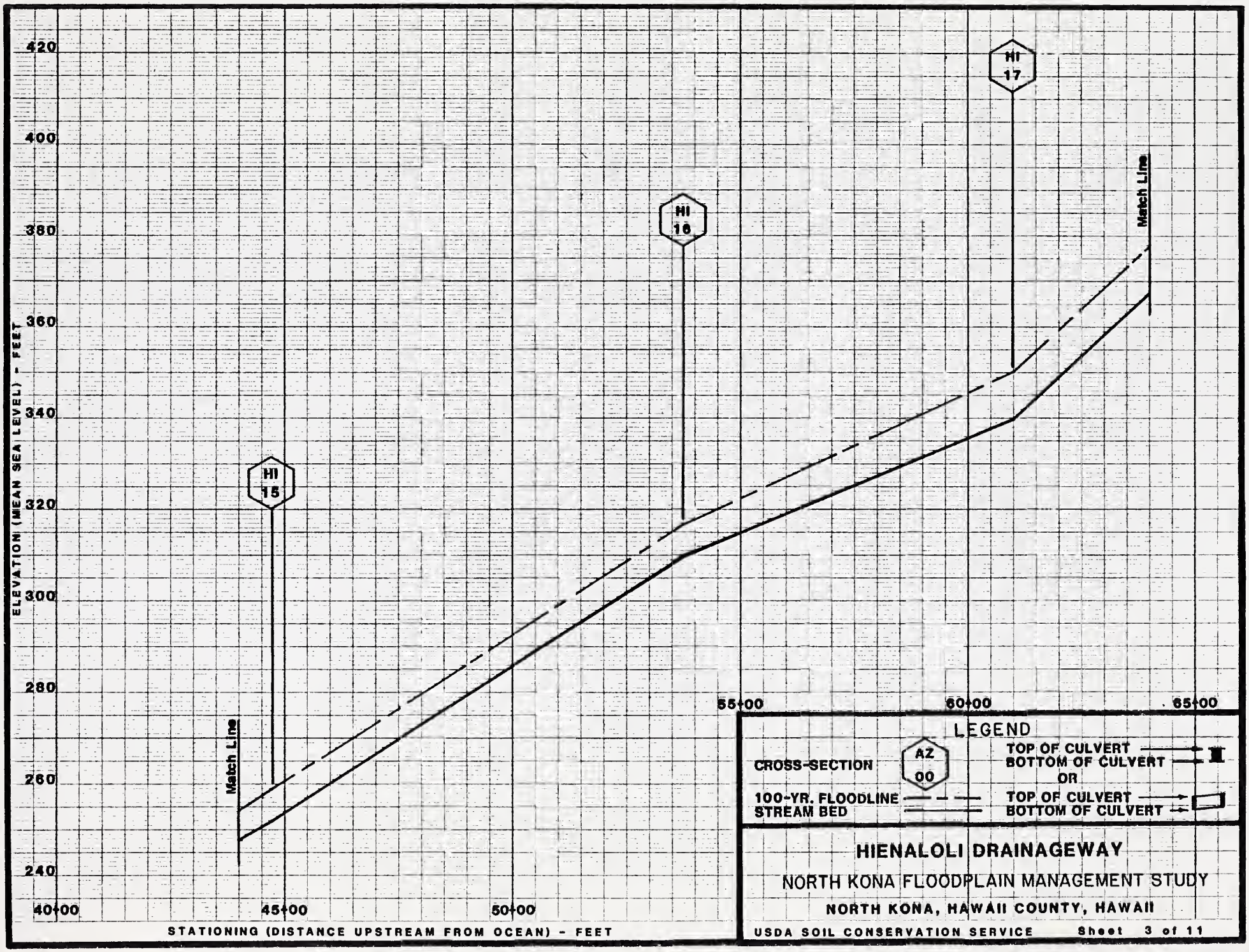


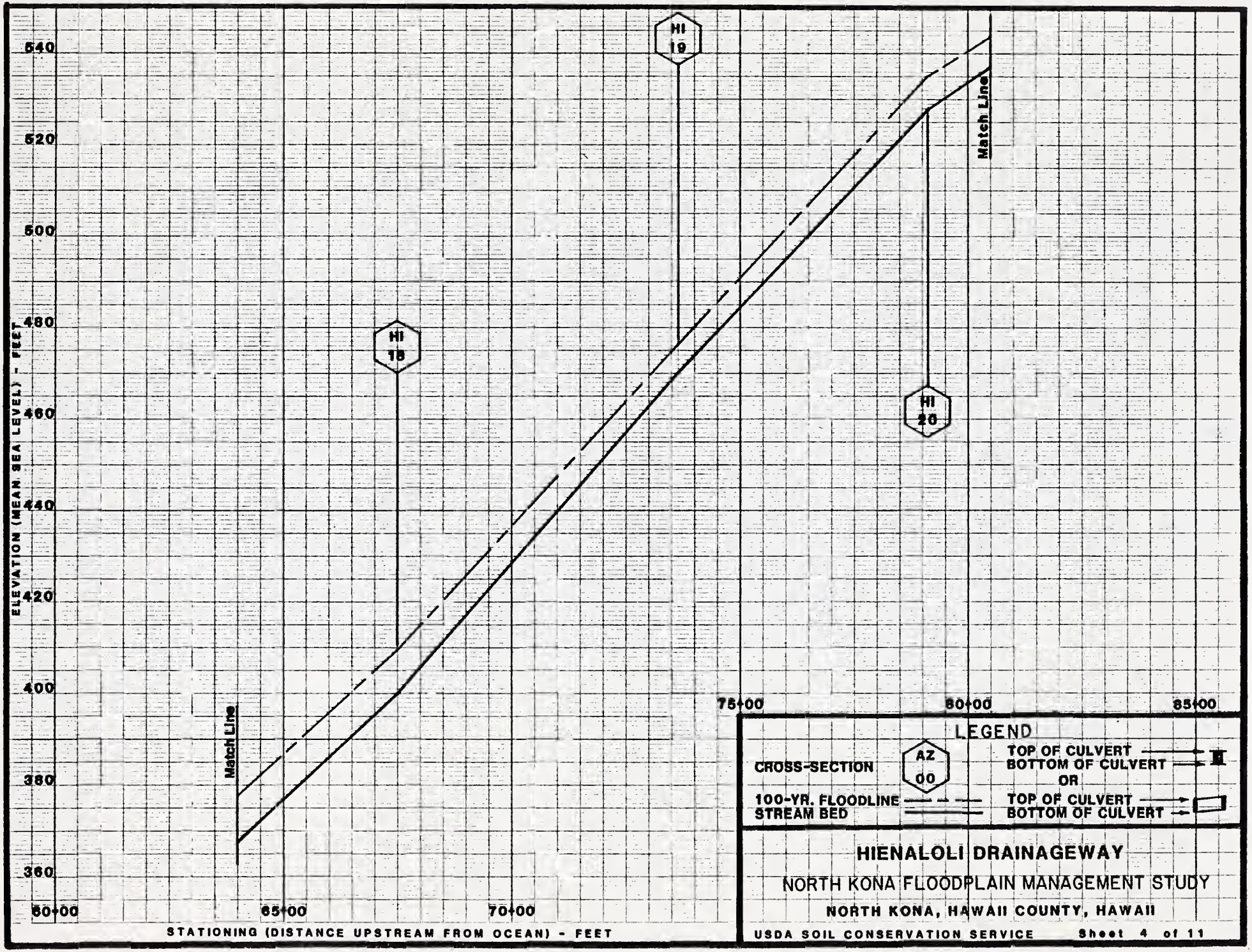
HIENALOLI DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


420
400
380
360
340
320
300
280
260
240
ELEVATION (MEAN SEA LEVEL) - FEET
HI 15
HI 16
HI 17
Match Line
Match Line
40+00
45+00
50+00
55+00
60+00
65+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
HIENALOLI DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 3 of 11

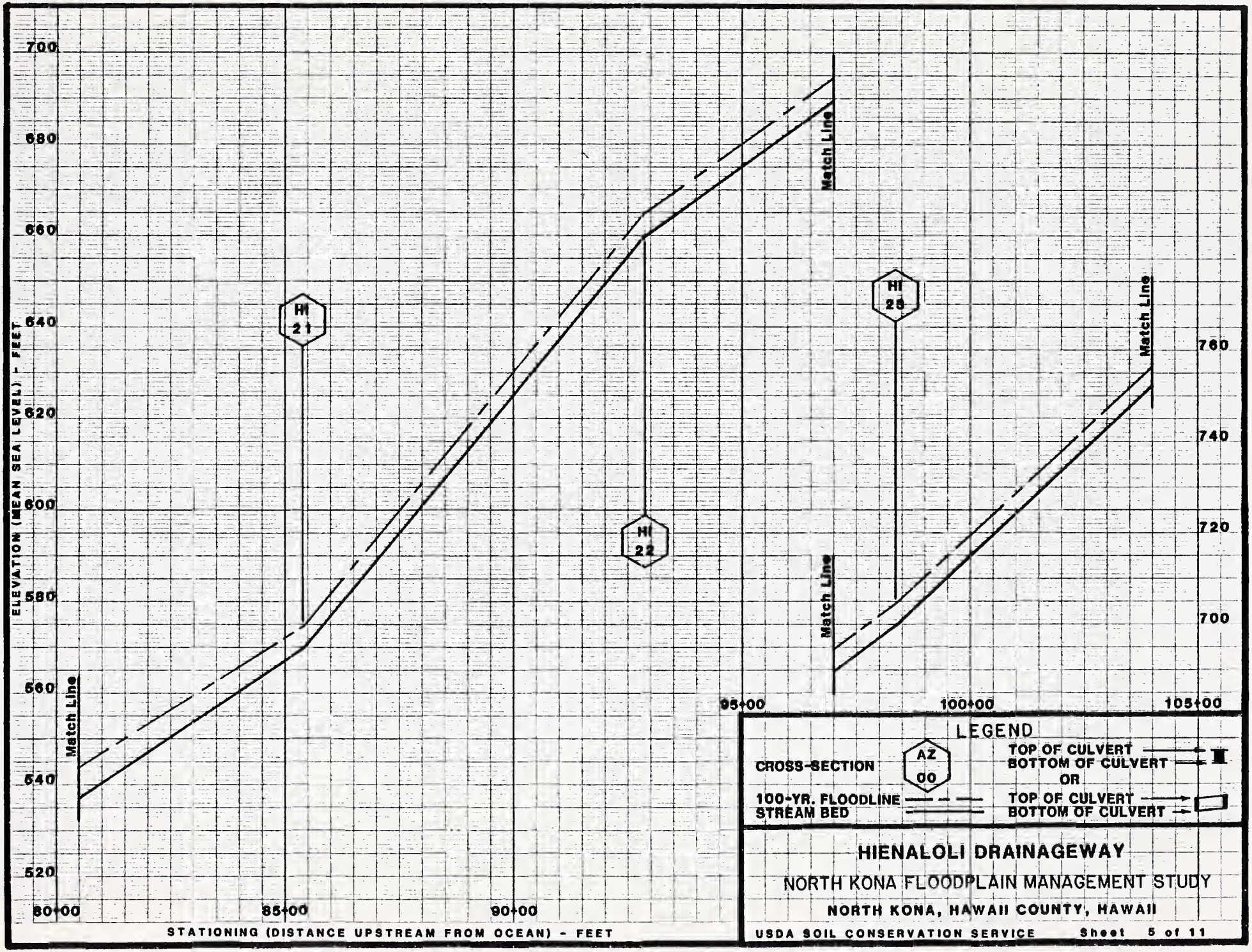


HIENALOLI DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

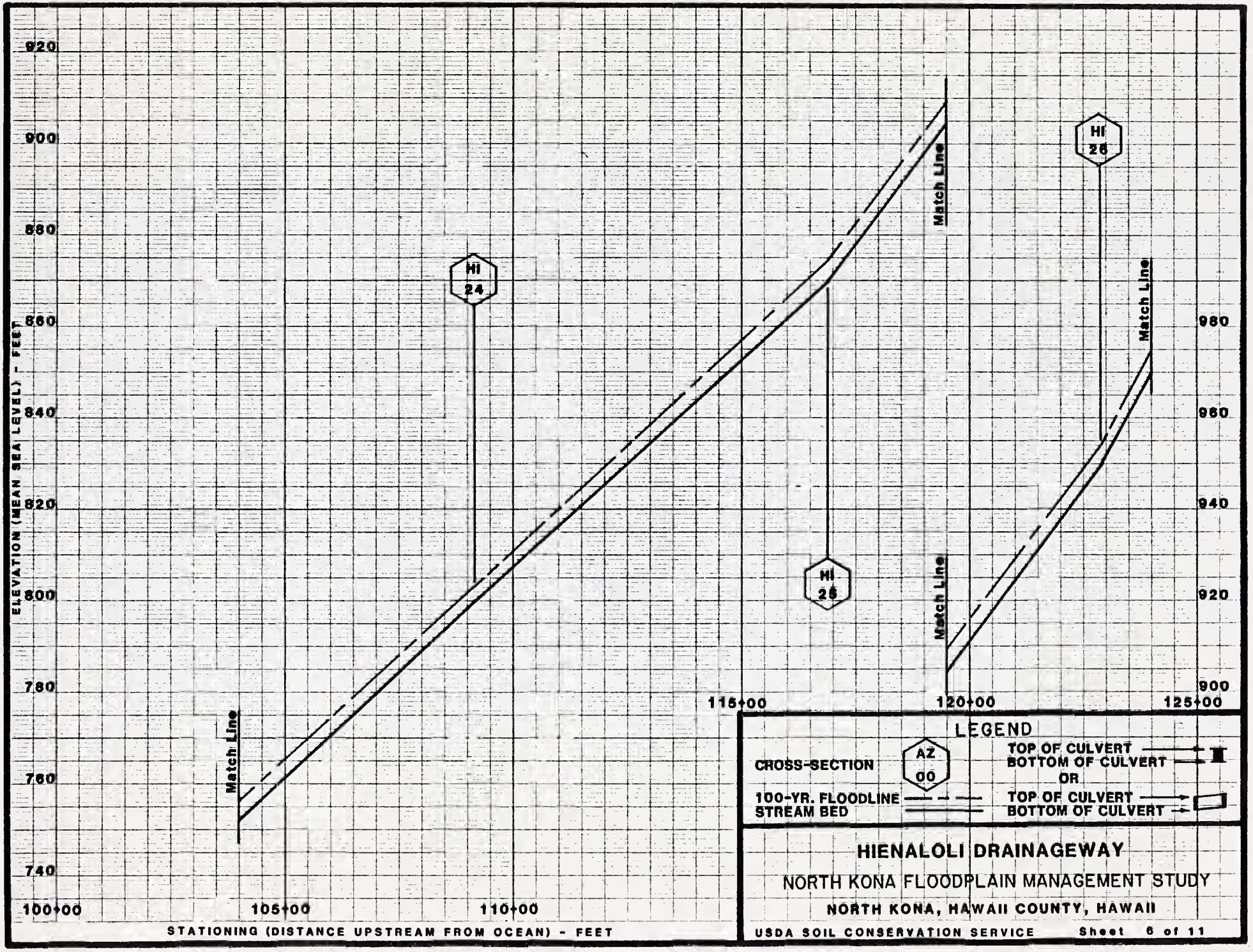


HIENALOLI DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

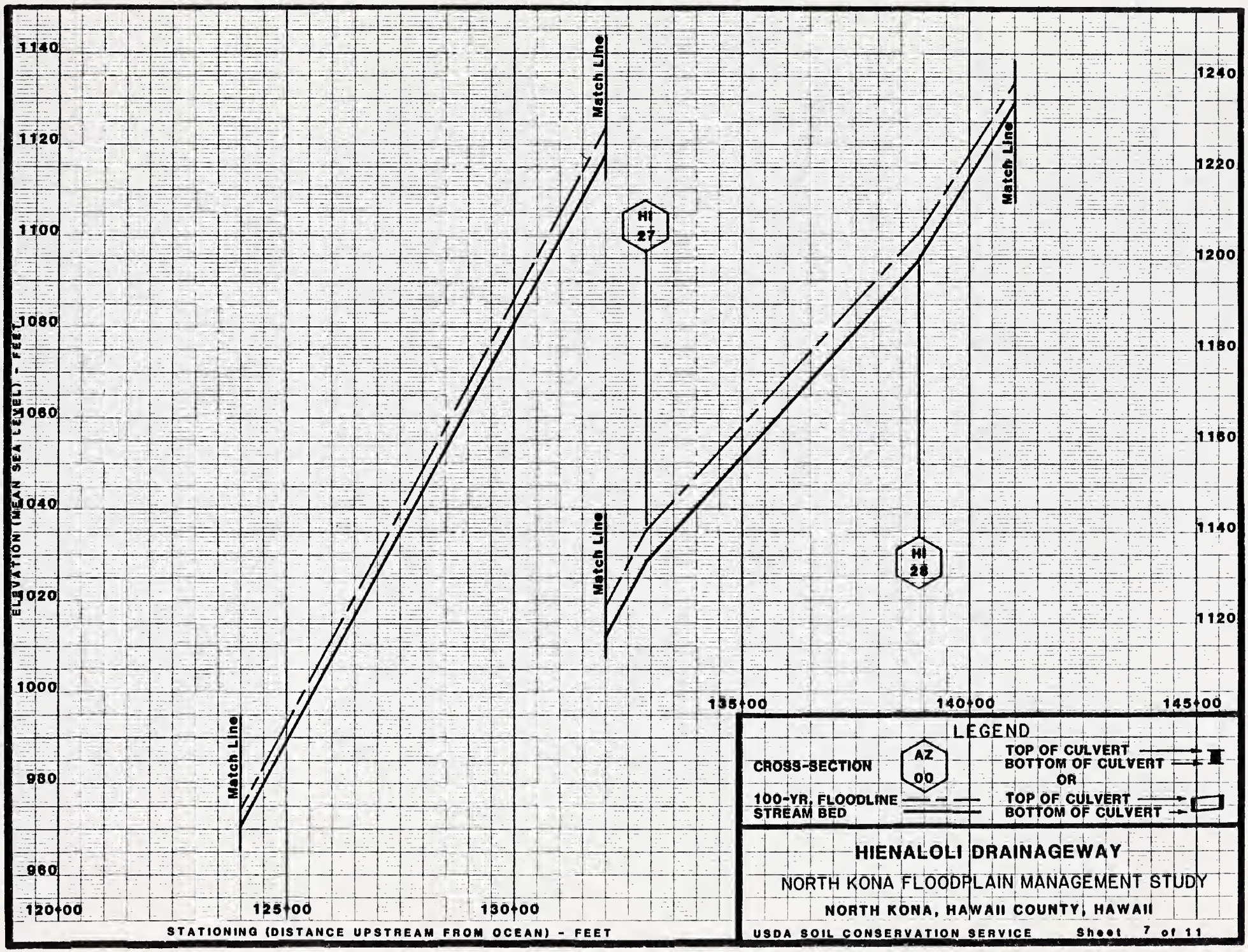


HIENALOLI DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

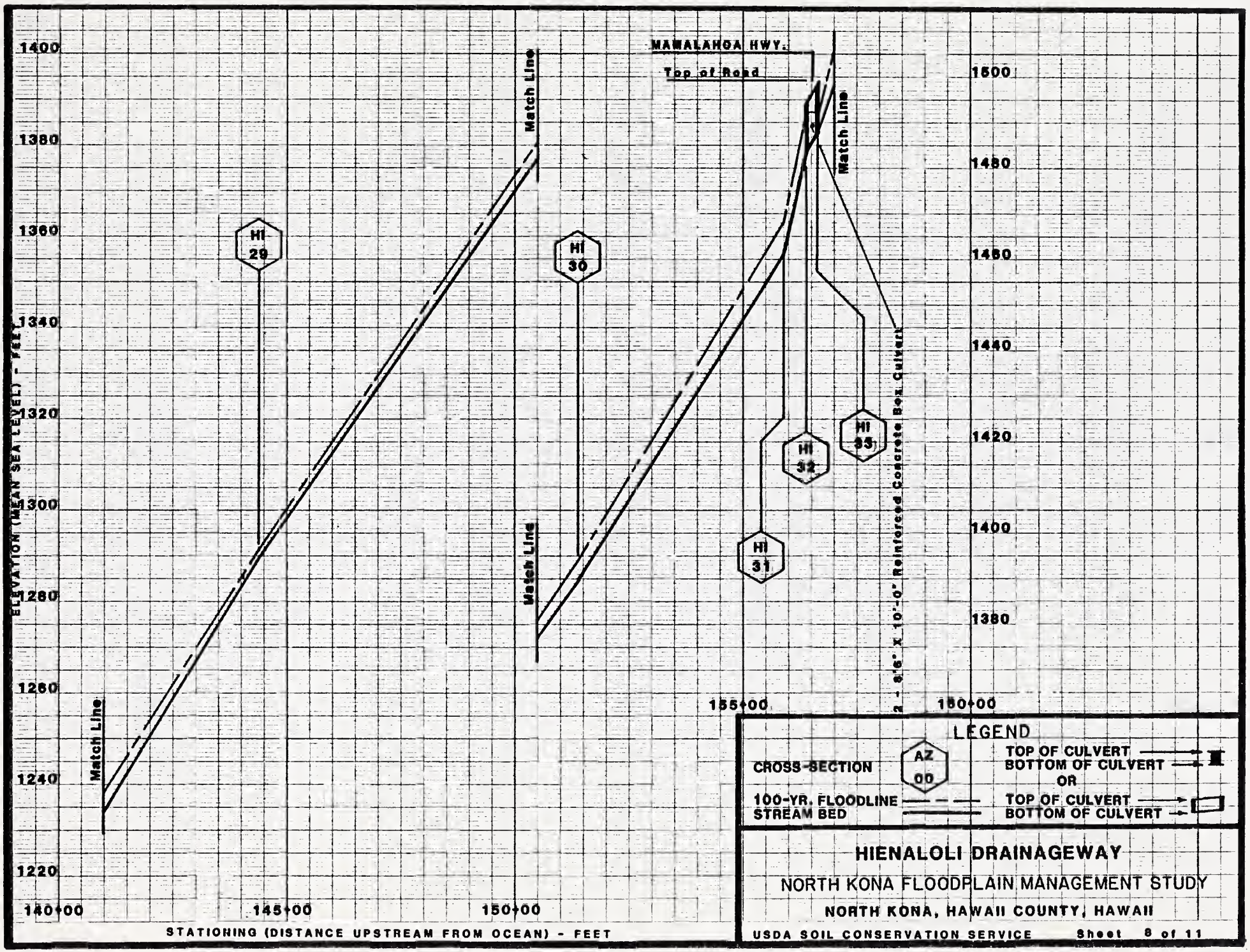


HIENALOLI DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

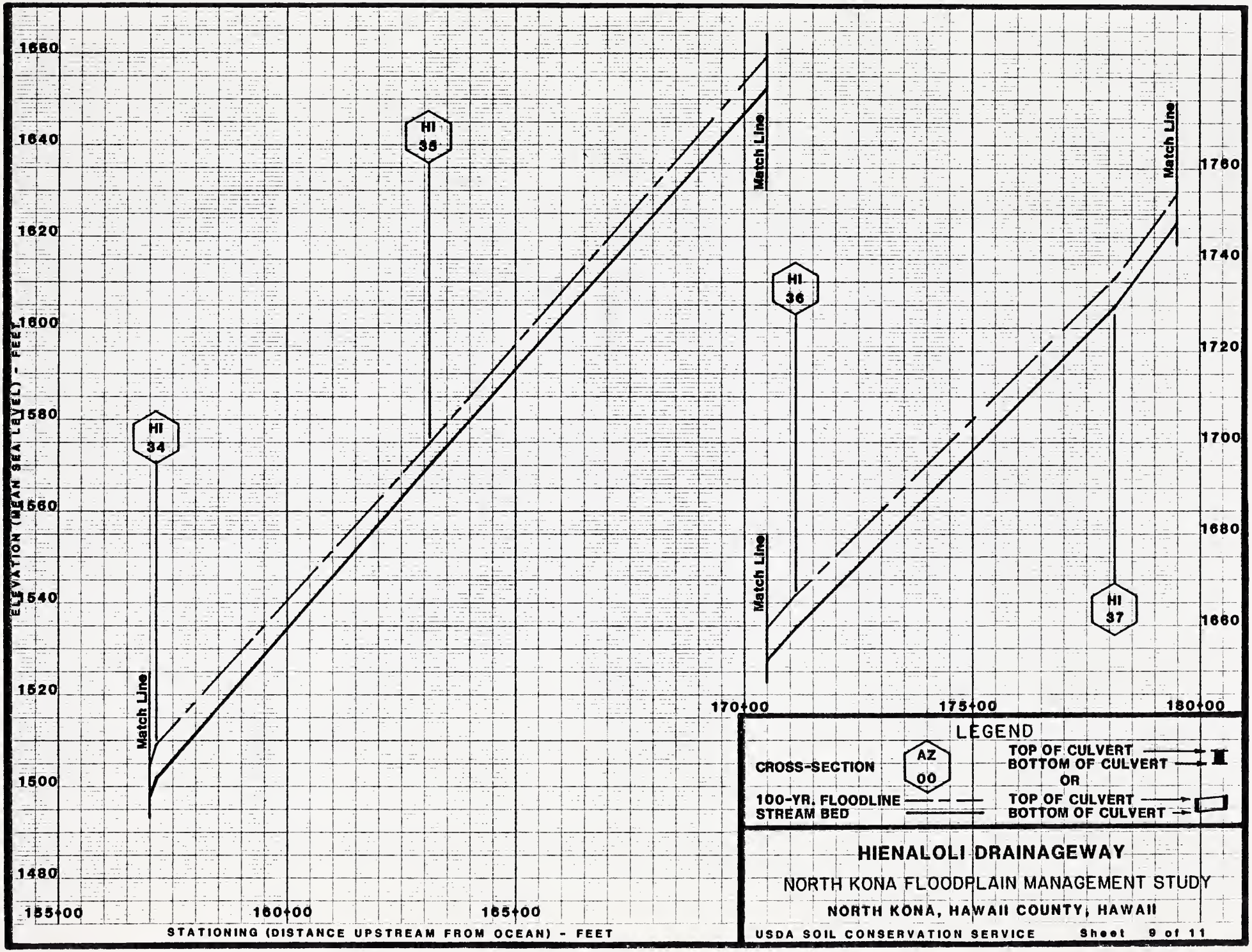


HIENALOLI DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

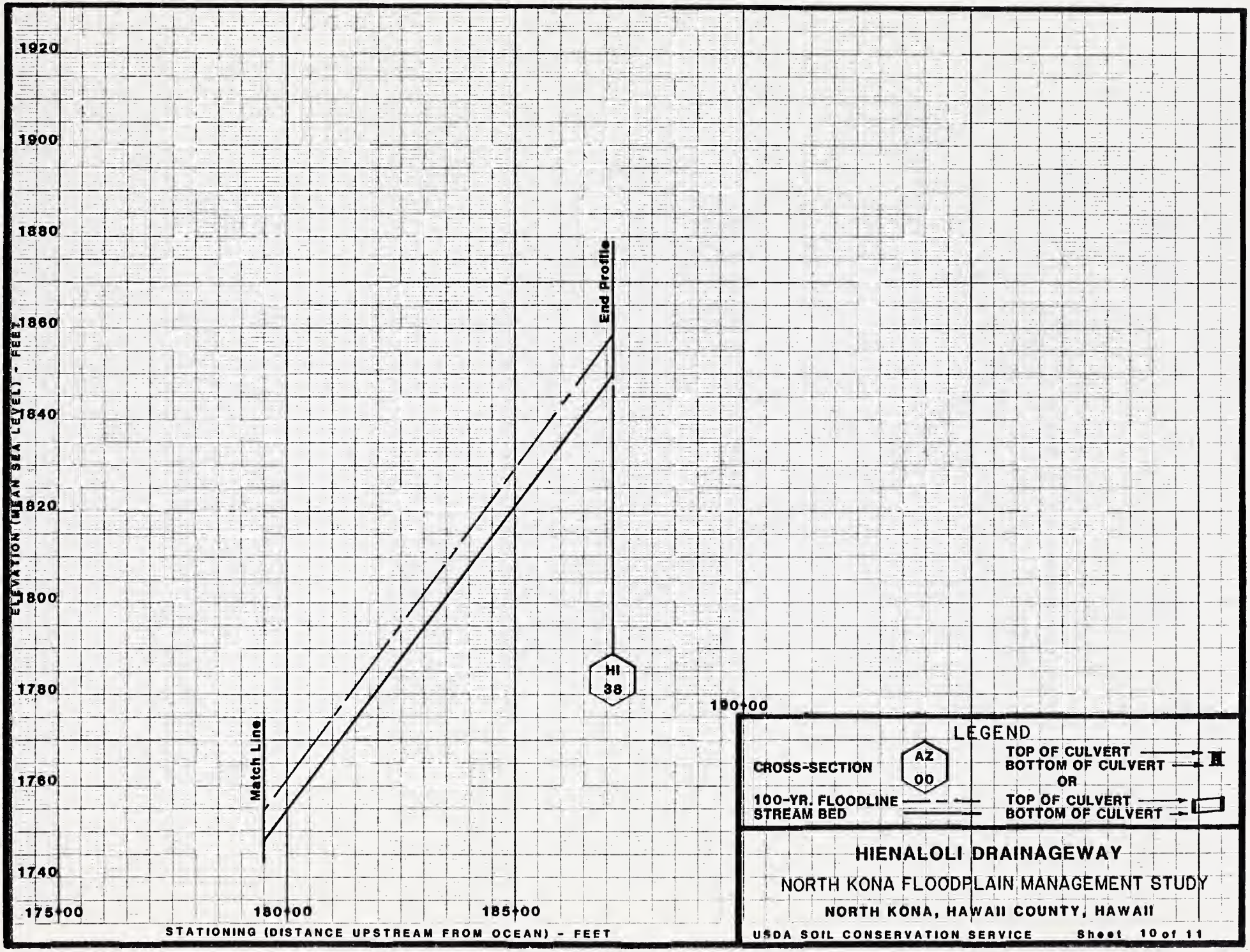


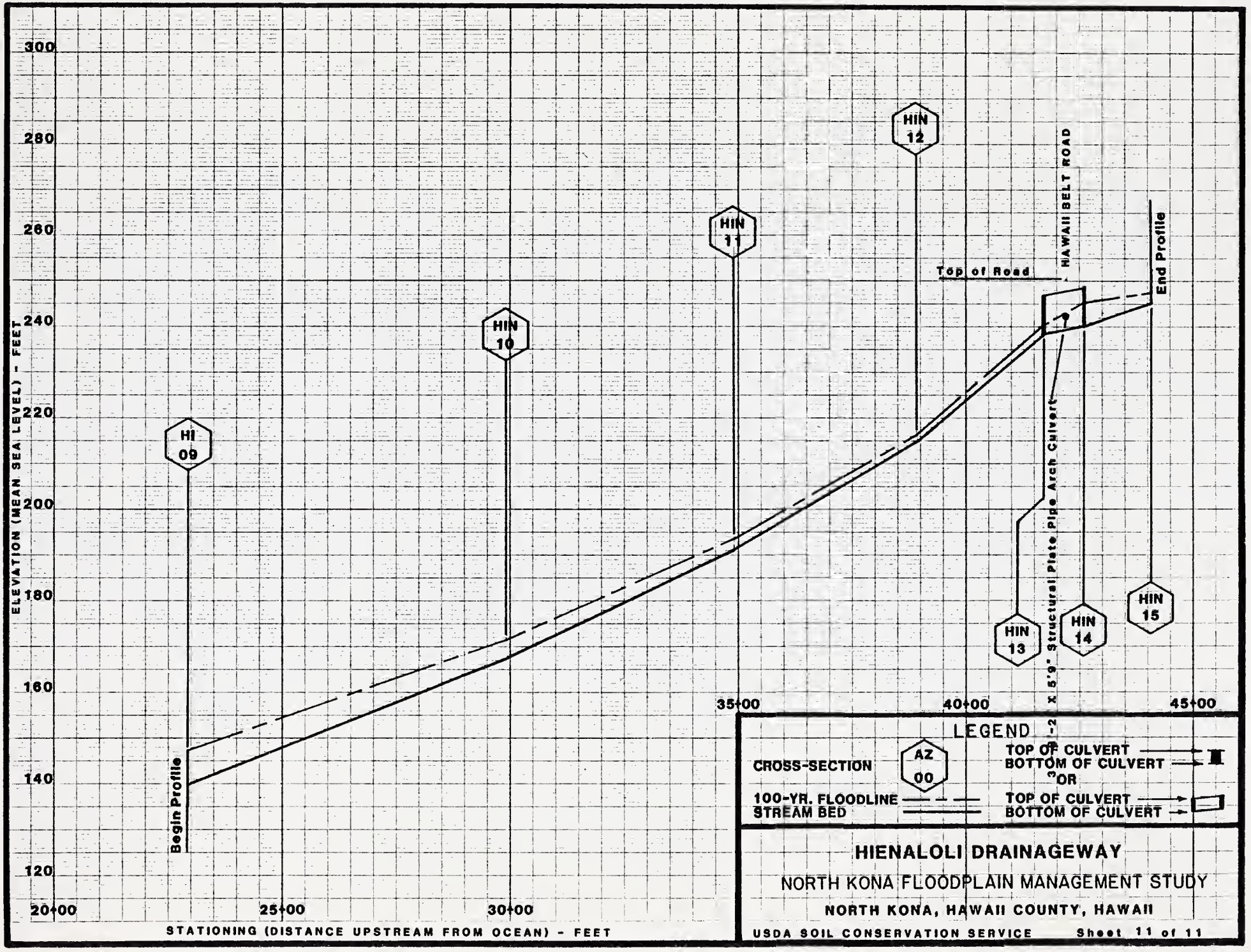
HIENALOLI DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


1920
1900
1880
1860
1840
1820
1800
1780
1760
1740
ELEVATION (MEAN SEA LEVEL) - FEET
End Profile
Match Line
HI
38
175+00
180+00
185+00
190+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
HIENALOLI DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 10 of 11

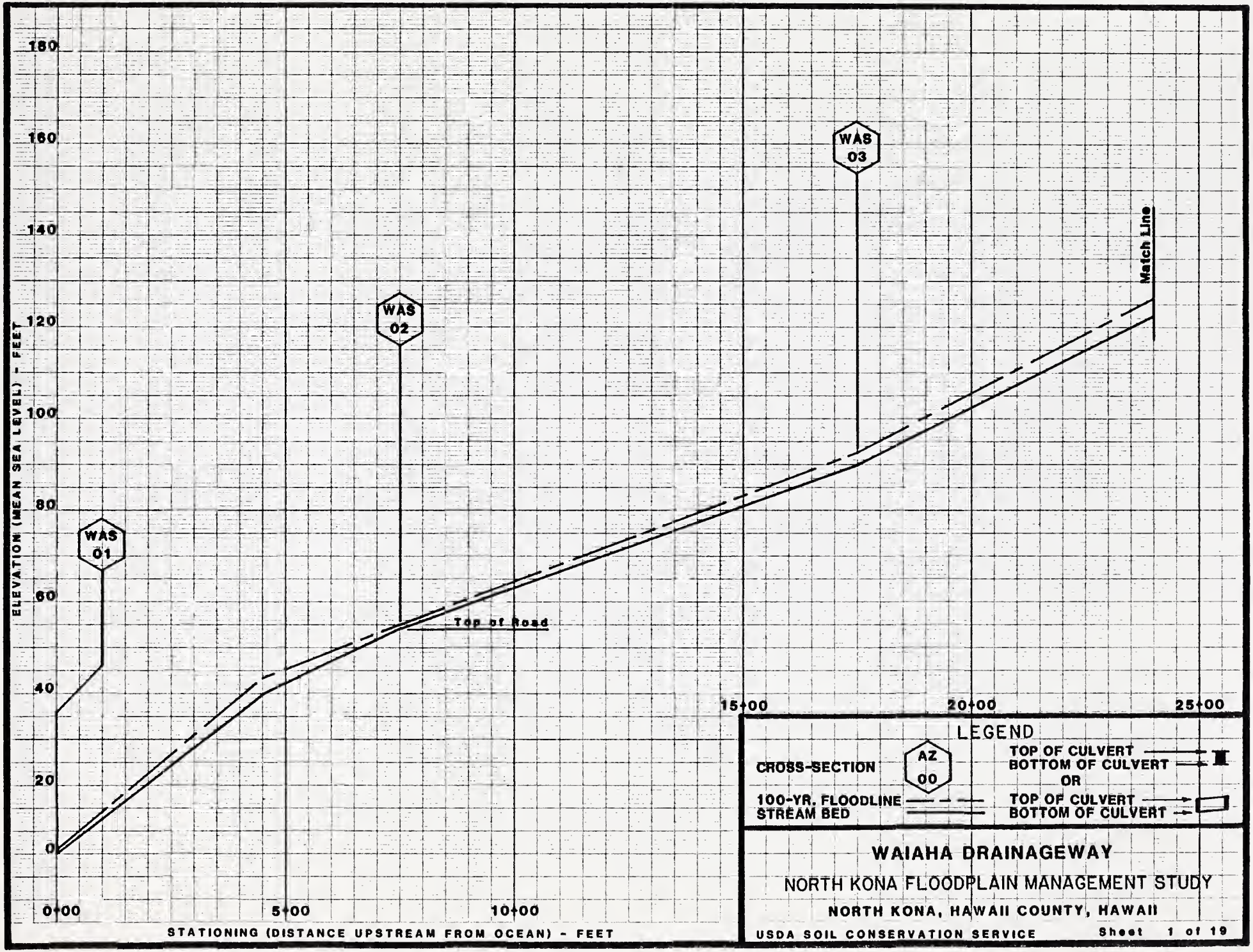


HIENALOLI DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

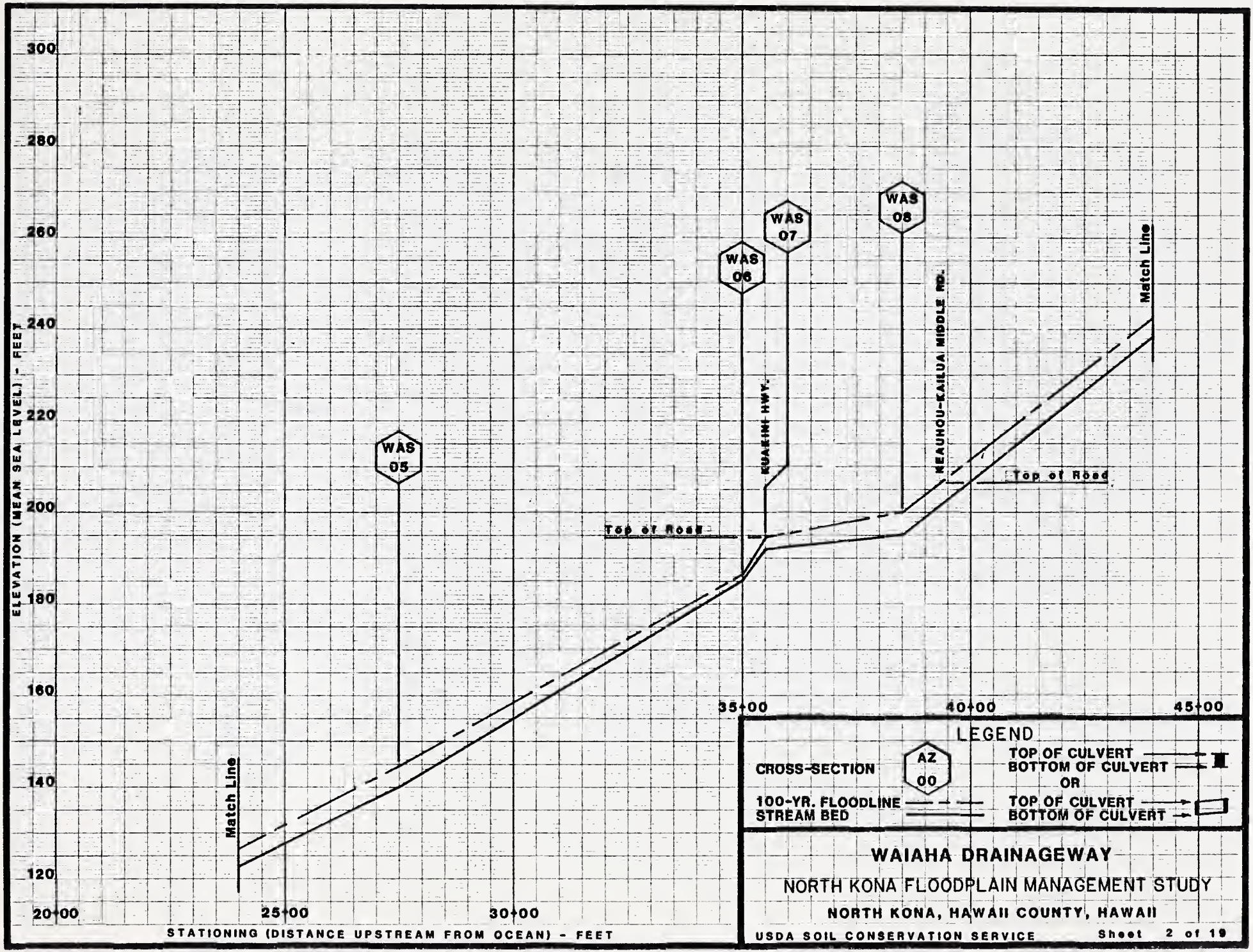


WAIAHA DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

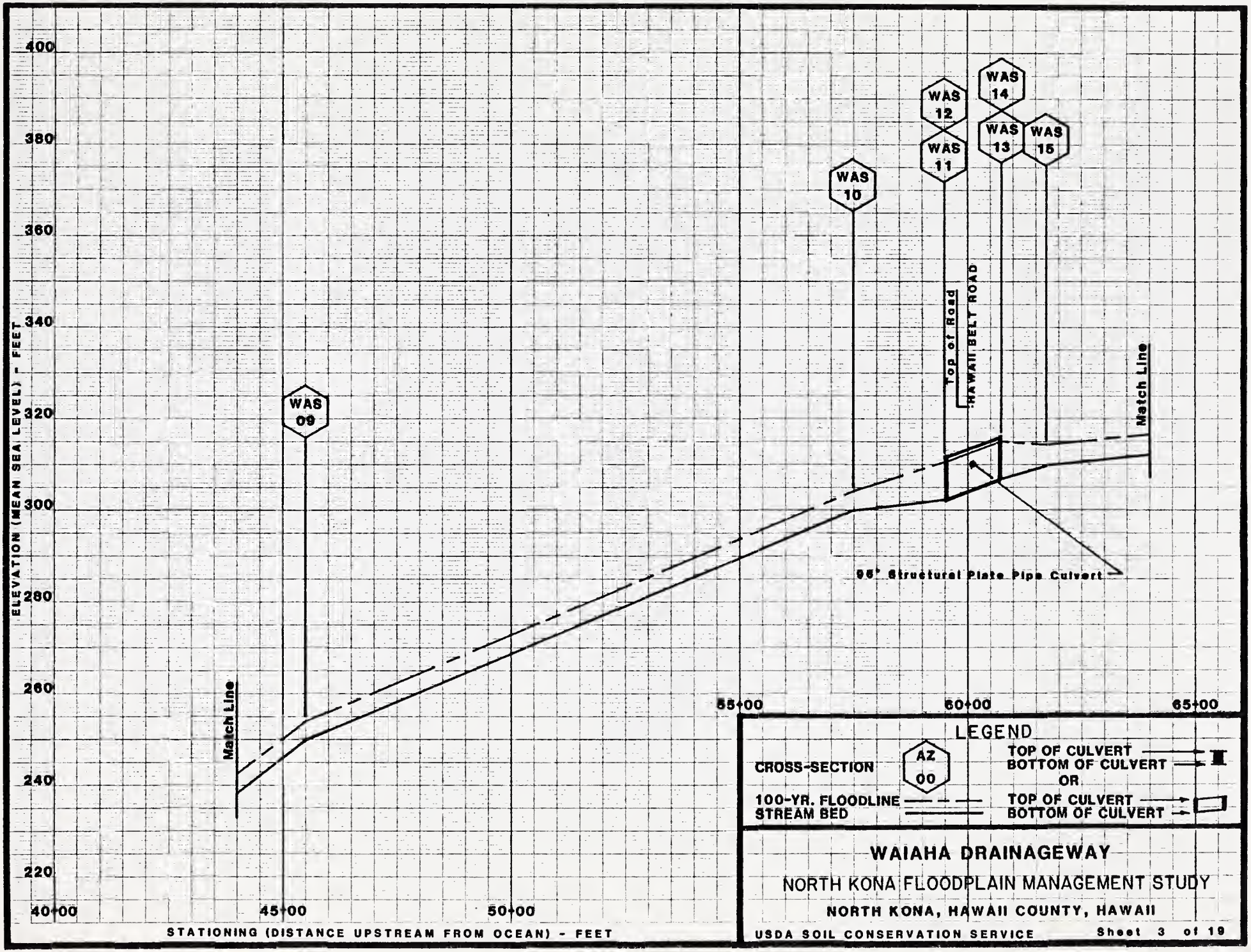


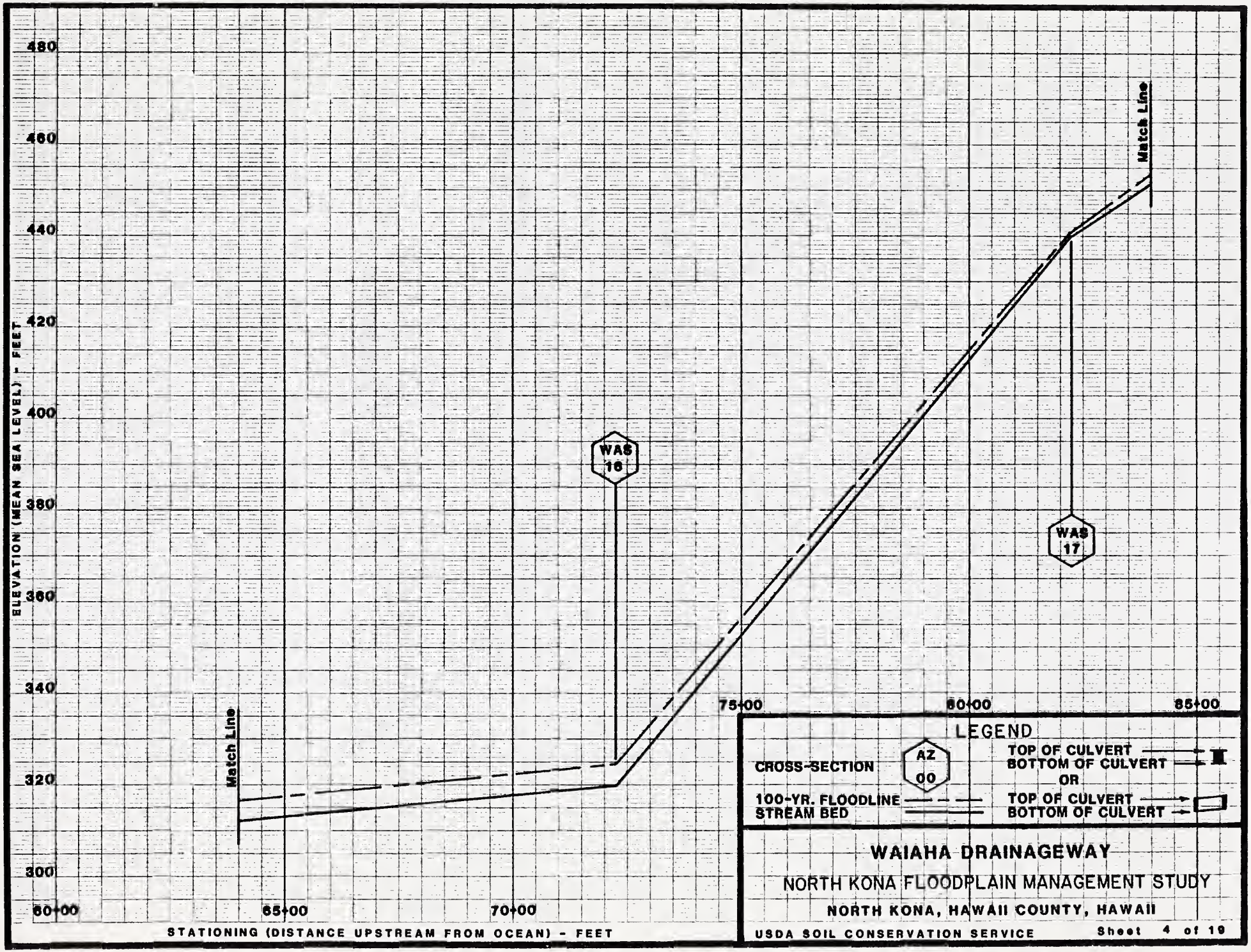
WAIAHA DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


400
380
360
340
320
300
280
260
240
220
ELEVATION (MEAN SEA LEVEL) - FEET
WAS 09
WAS 10
WAS 11
WAS 12
WAS 13
WAS 14
WAS 15
Top of Road
HAWAII BELT ROAD
Match Line
Match Line
95" Structural Plate Pipe Culvert
40+00
45+00
50+00
55+00
60+00
65+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
WAIAHA DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 3 of 19

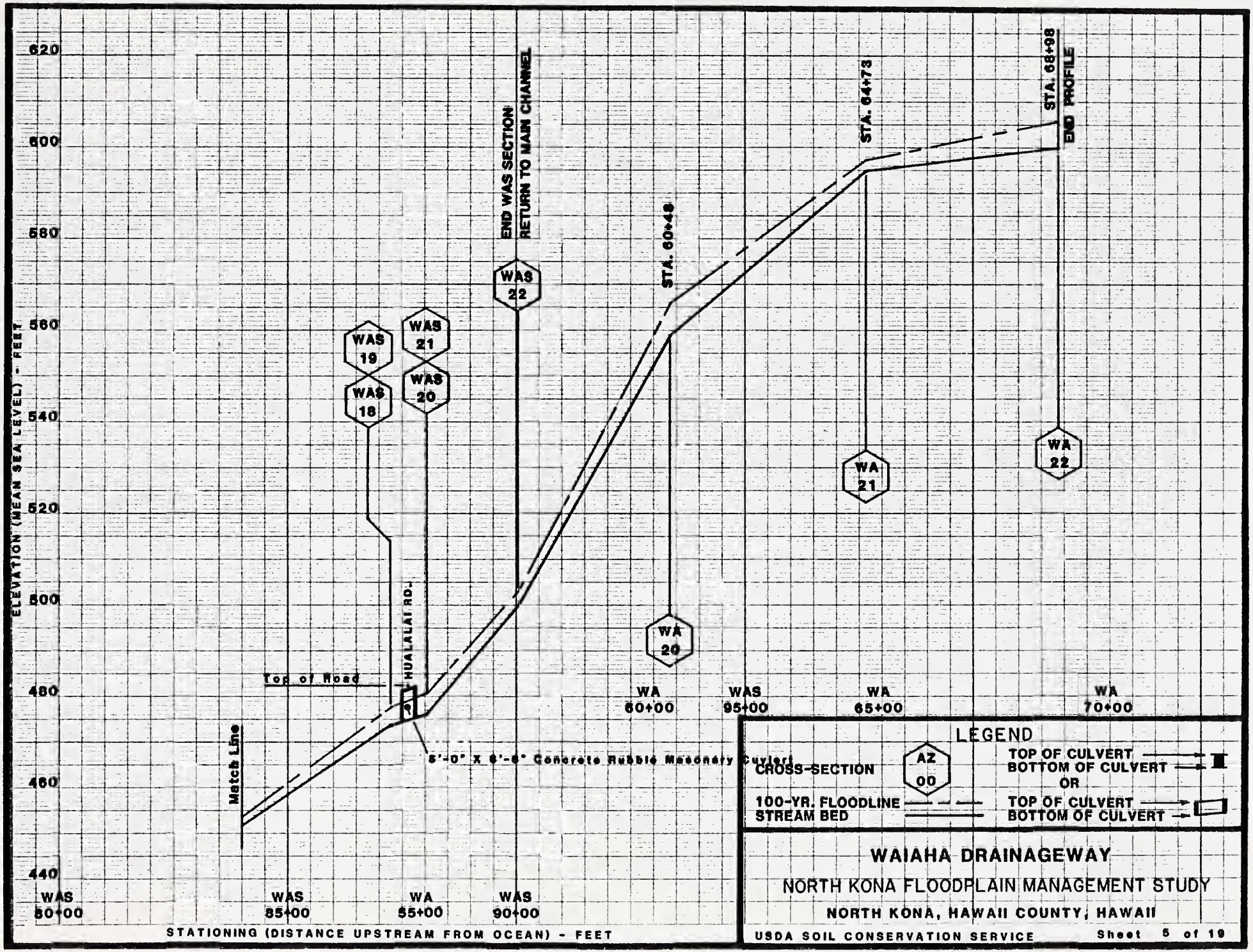


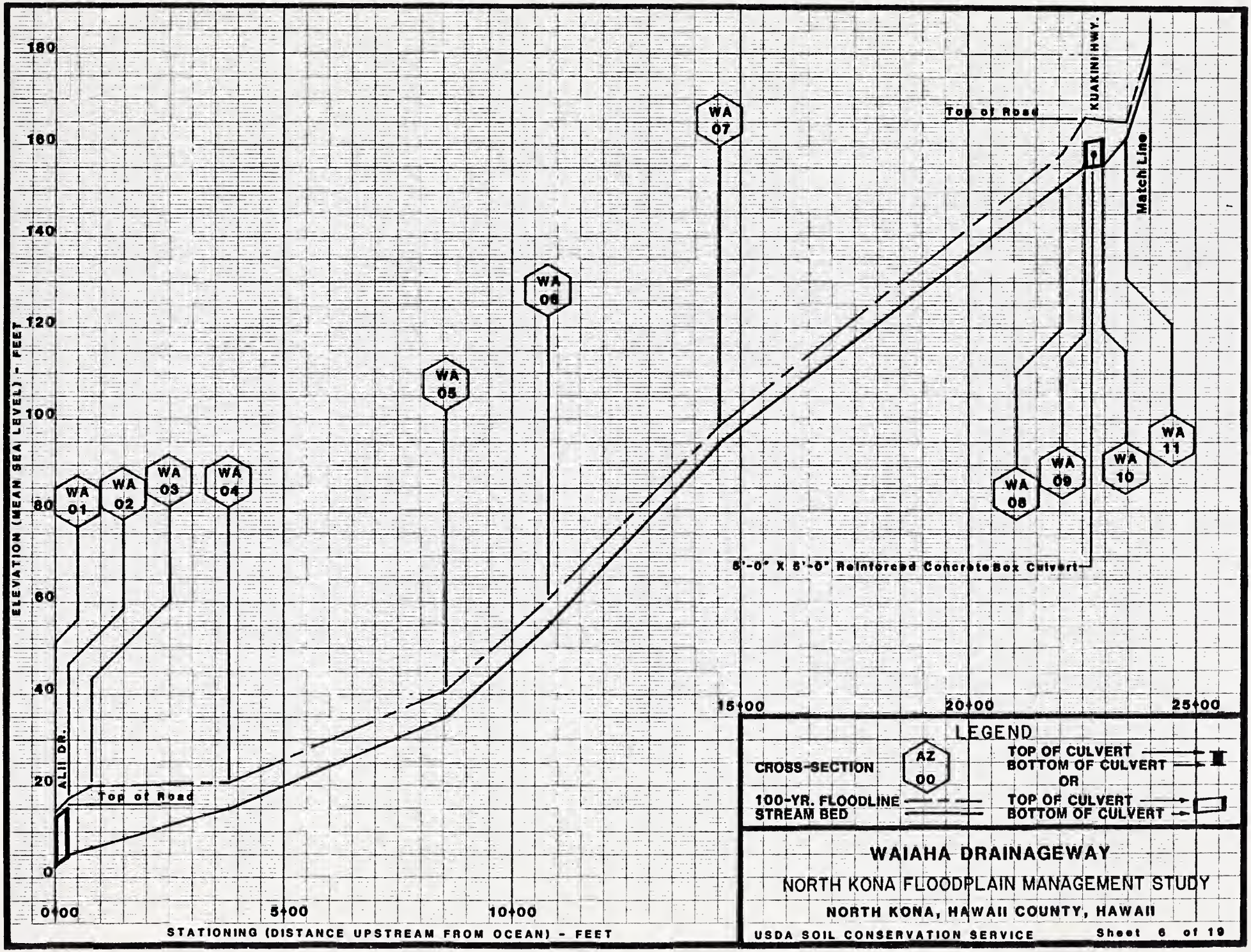
WAIAHA DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


620
600
580
560
540
520
500
480
460
440
ELEVATION (MEAN SEA LEVEL) - FEET
WAS 80+00
WAS 85+00
WA 55+00
WAS 90+00
WA 60+00
WAS 95+00
WA 65+00
WA 70+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
Match Line
Top of Road
HUALALAI RD.
5'-0" X 6'-6" Concrete Rubble Masonry Culvert
END WAS SECTION
RETURN TO MAIN CHANNEL
WAS 22
WAS 21
WAS 20
WAS 19
WAS 18
STA. 60+48
STA. 64+73
STA. 68+98
END PROFILE
WA 22
WA 21
WA 20
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
WAIAHA DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 5 of 19

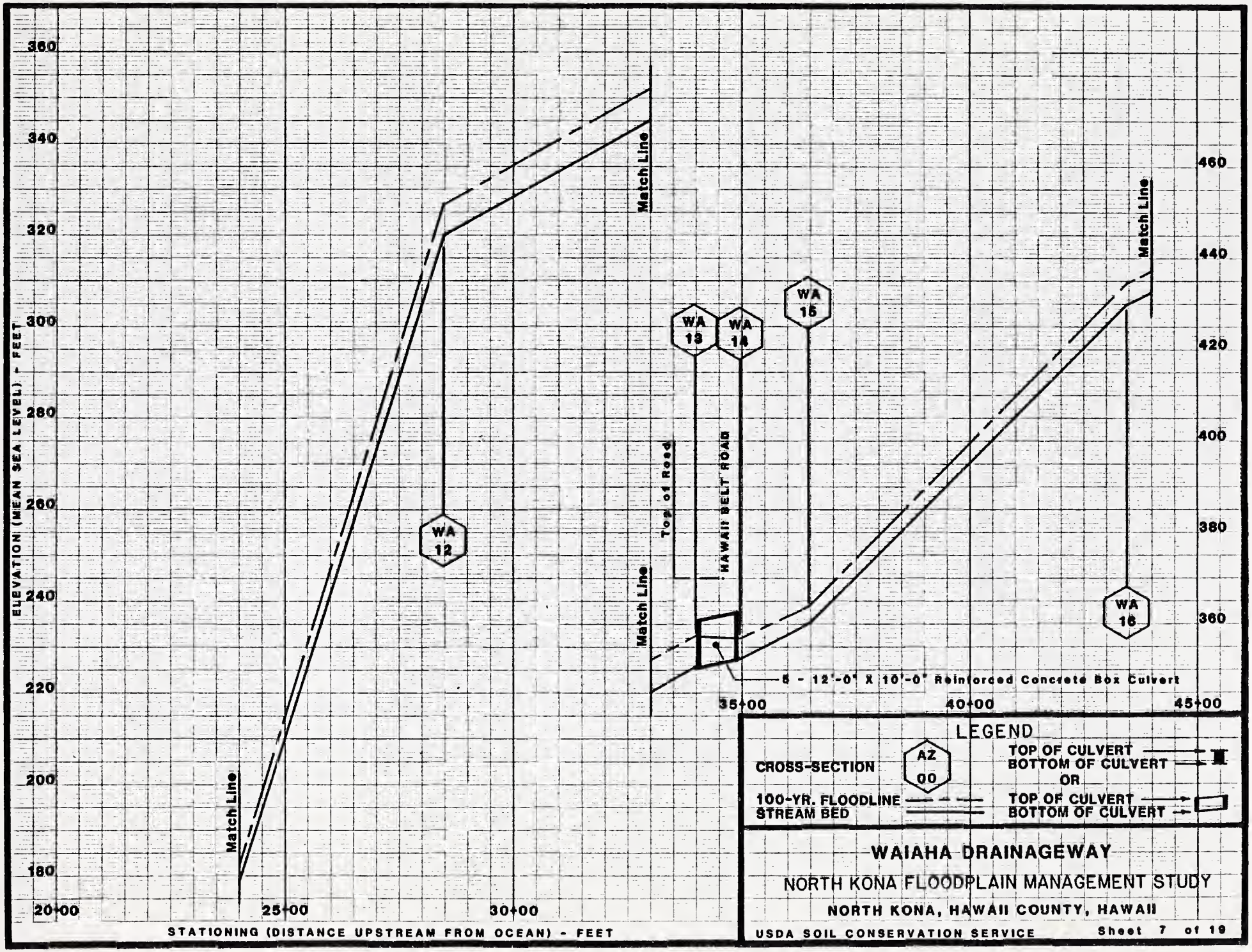


WAIAHA DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

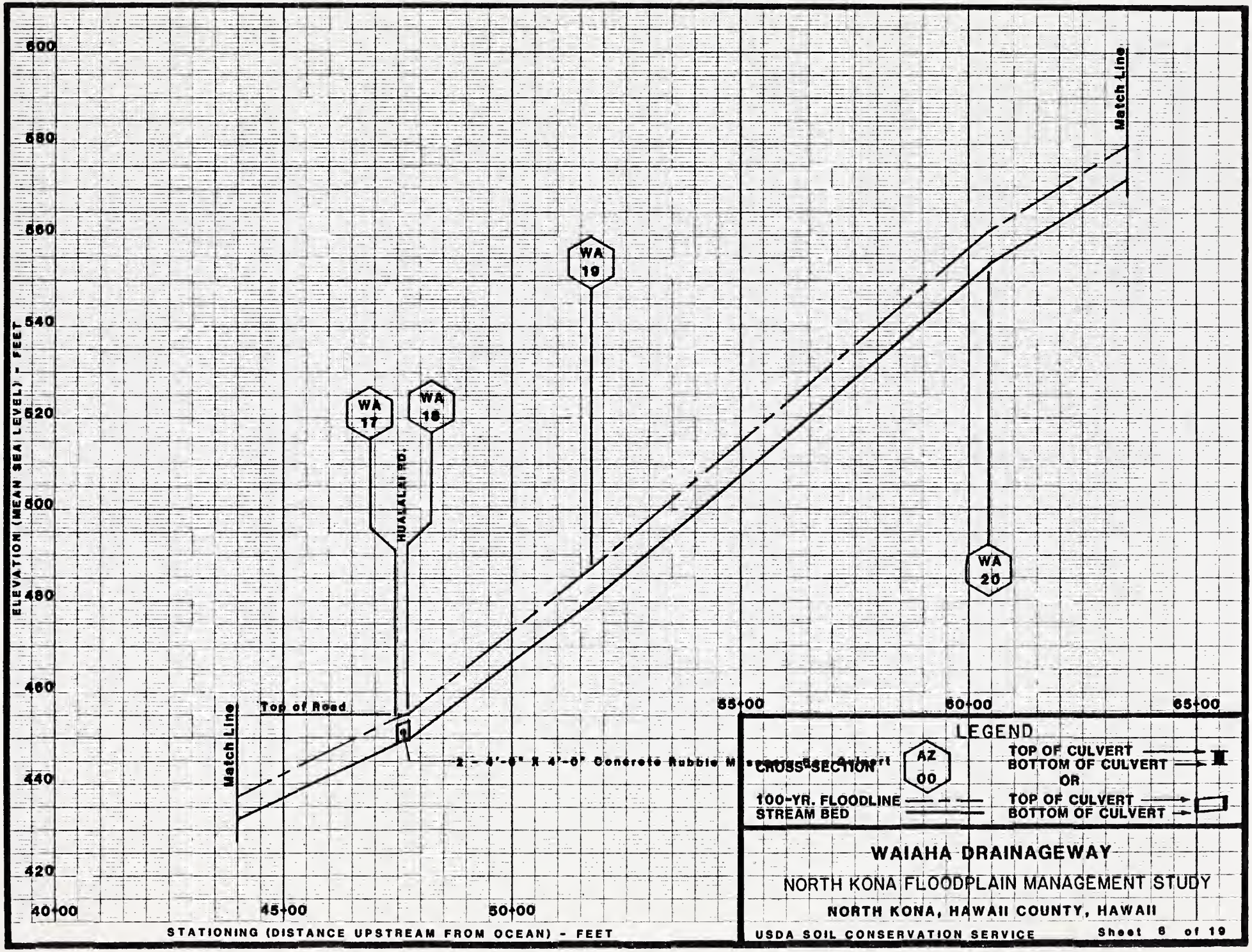


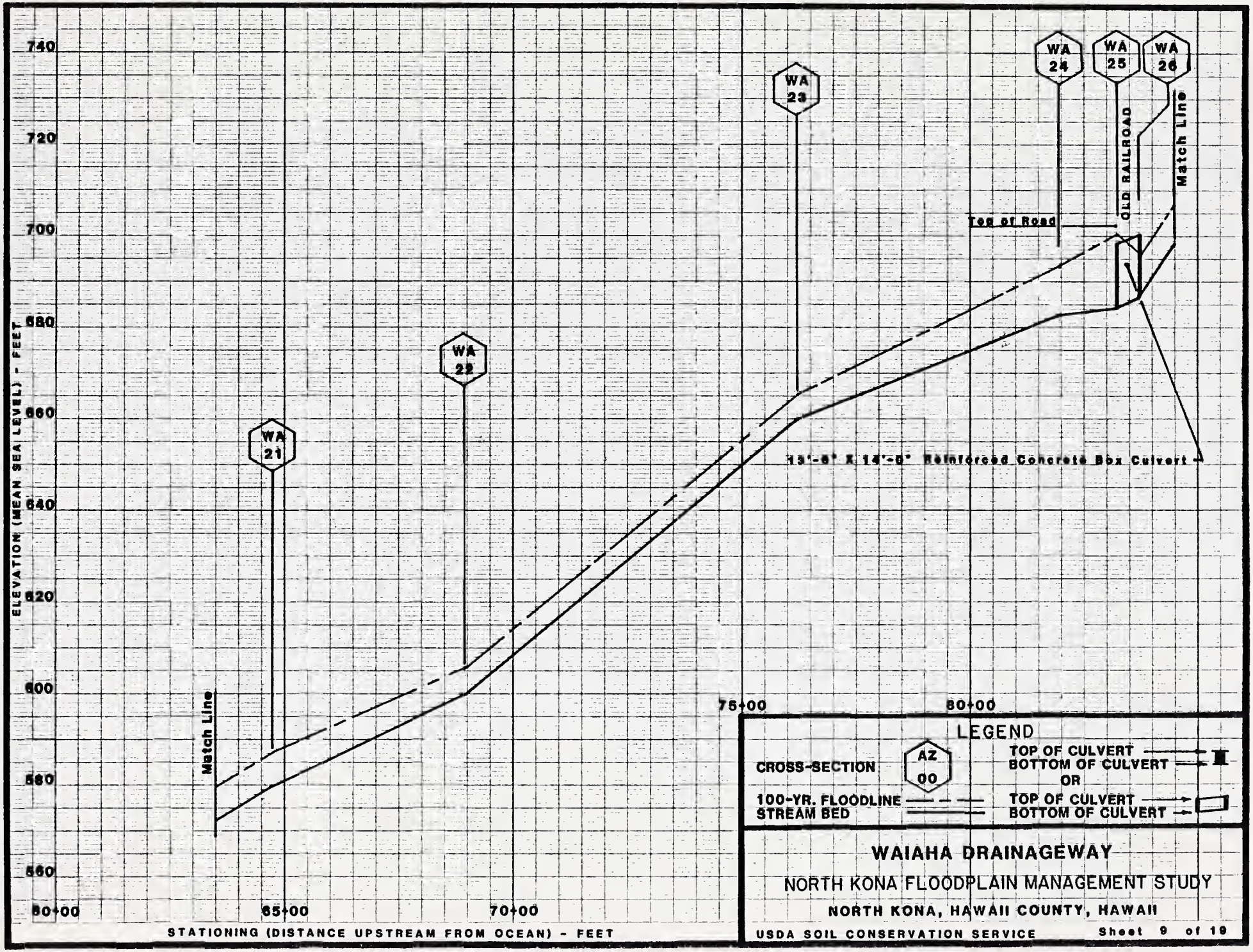
WAIAHA DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


600
580
560
540
520
500
480
460
440
420
ELEVATION (MEAN SEA LEVEL) - FEET
40+00
45+00
50+00
55+00
60+00
65+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
Match Line
Top of Road
WA 17
WA 18
WA 19
WA 20
HUALALAI RD.
2 - 6'-0" X 4'-0" Concrete Rubble M
Culvert
CROSS-SECTION
AZ
00
LEGEND
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
100-YR. FLOODLINE
STREAM BED
WAIAHA DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 6 of 19

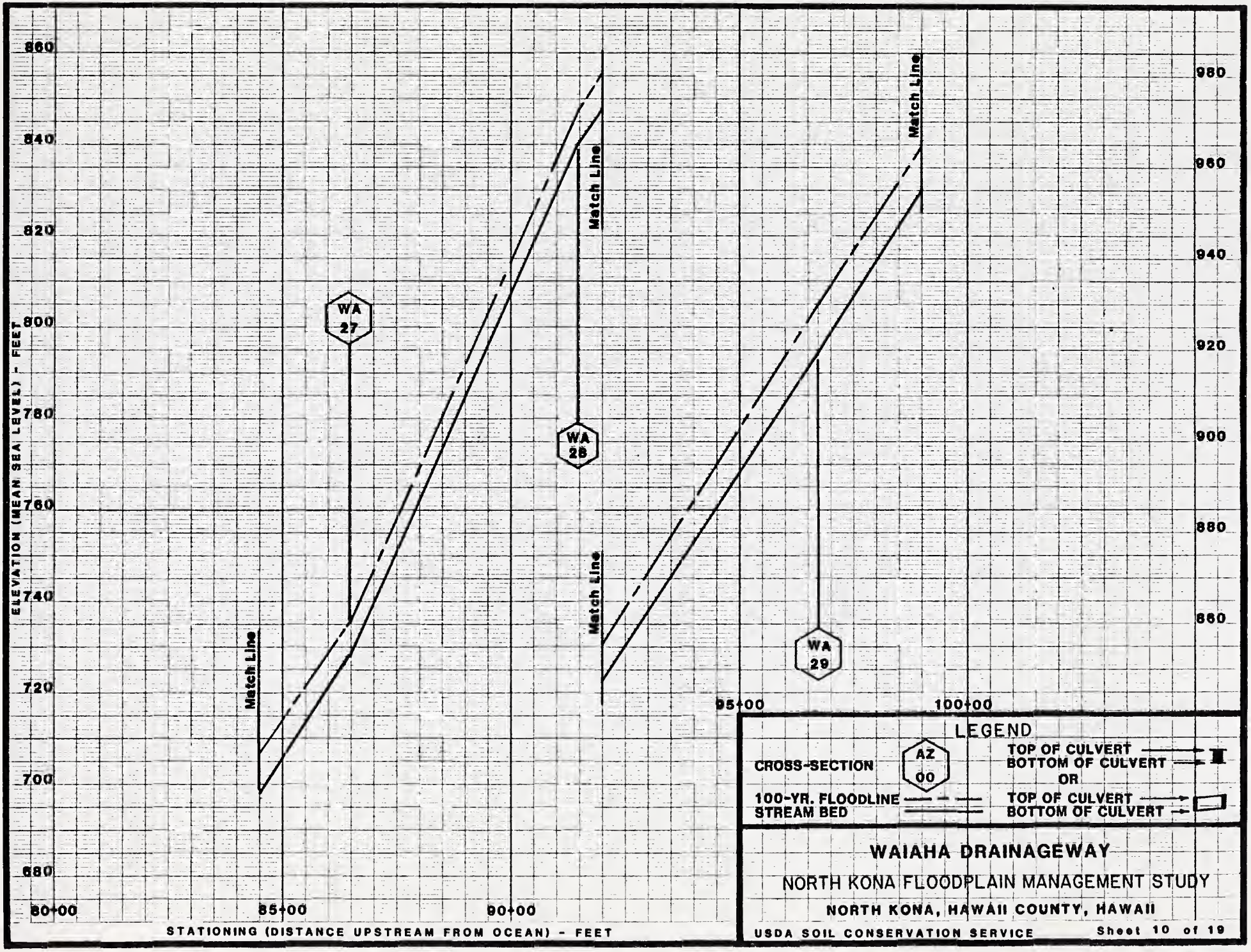


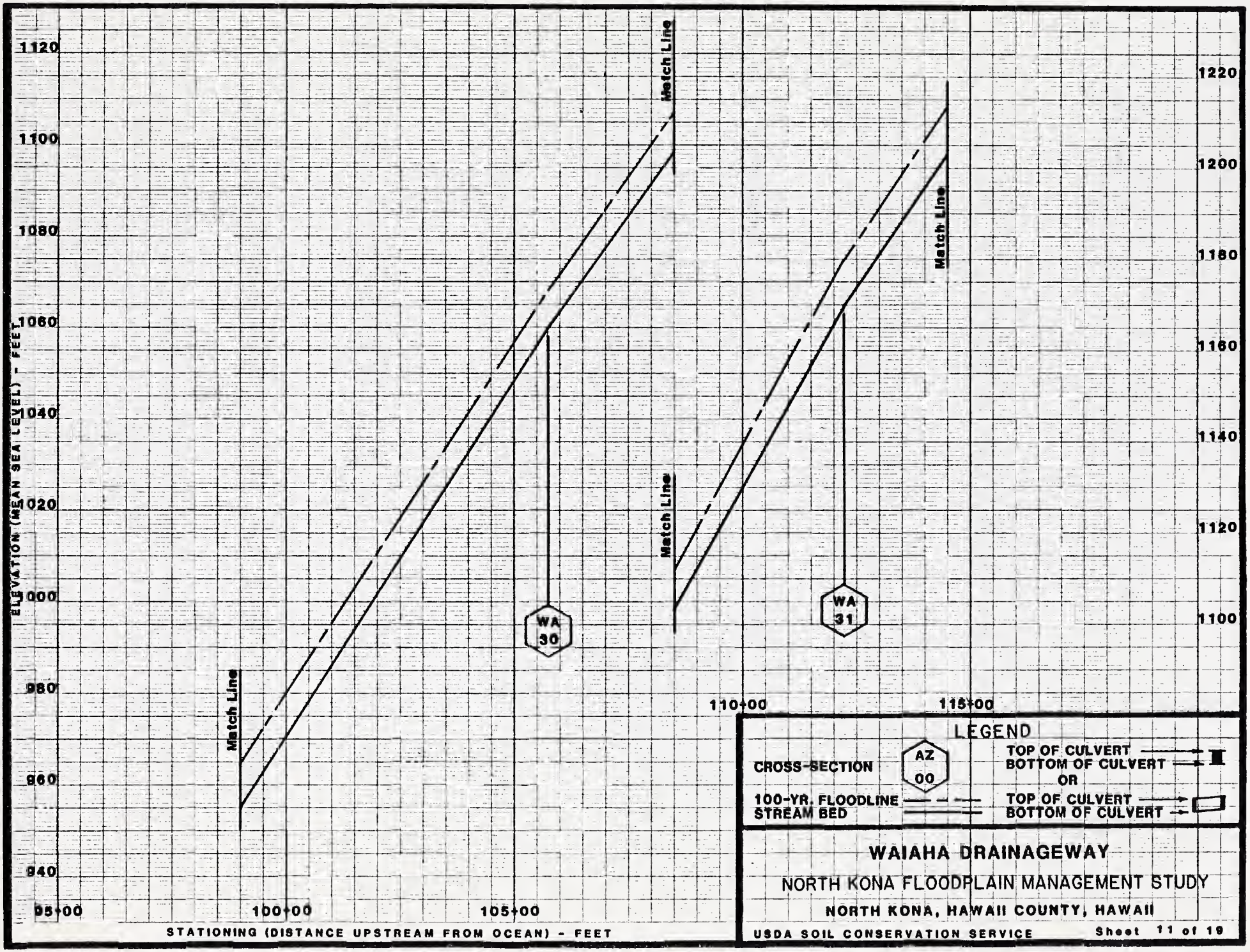
WAIAHA DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


ELEVATION (MEAN SEA LEVEL) - FEET
860
840
820
800
780
760
740
720
700
680
980
960
940
920
900
880
860
WA 27
WA 28
WA 29
Match Line
Match Line
Match Line
80+00
85+00
90+00
95+00
100+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
WAIAHA DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 10 of 19

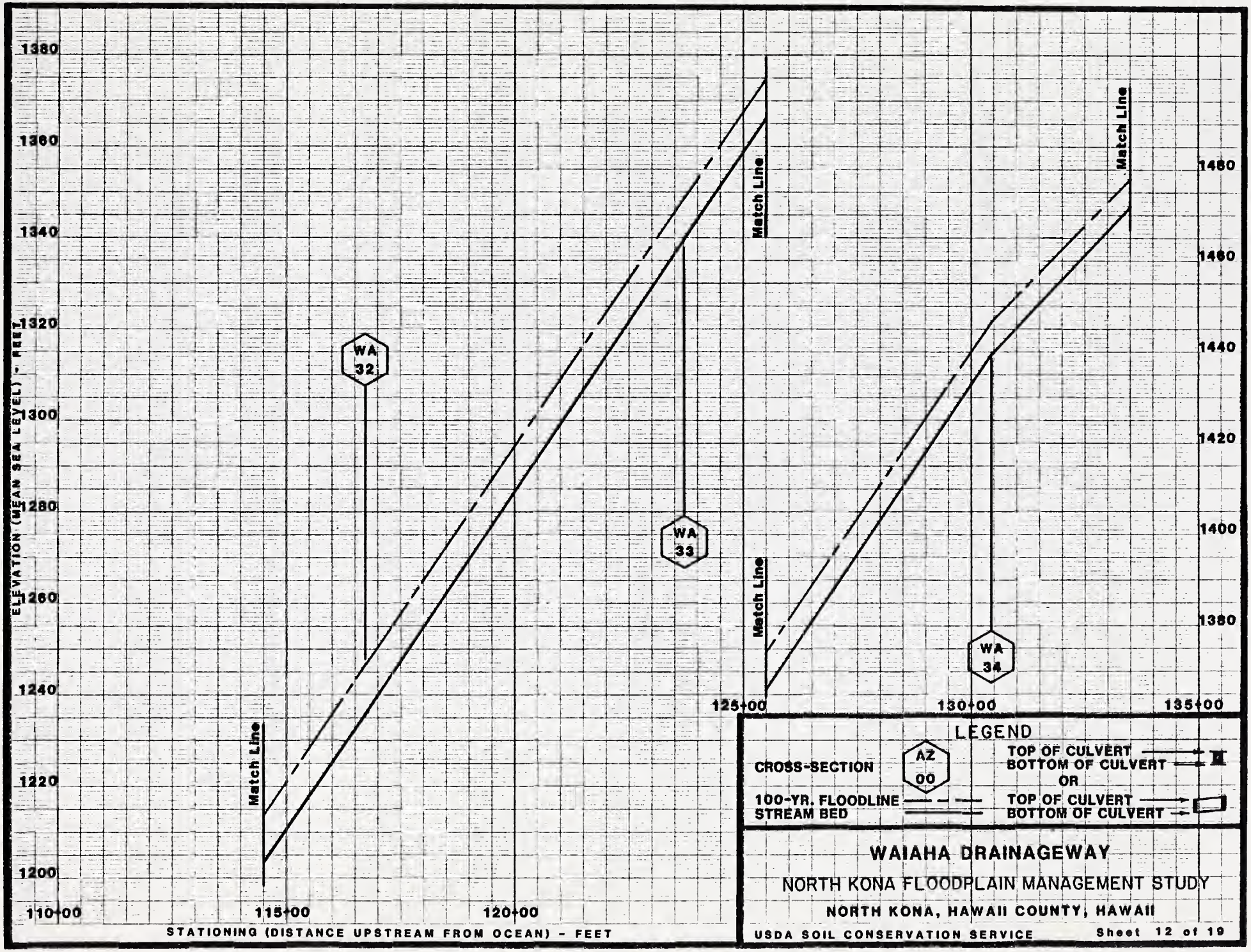


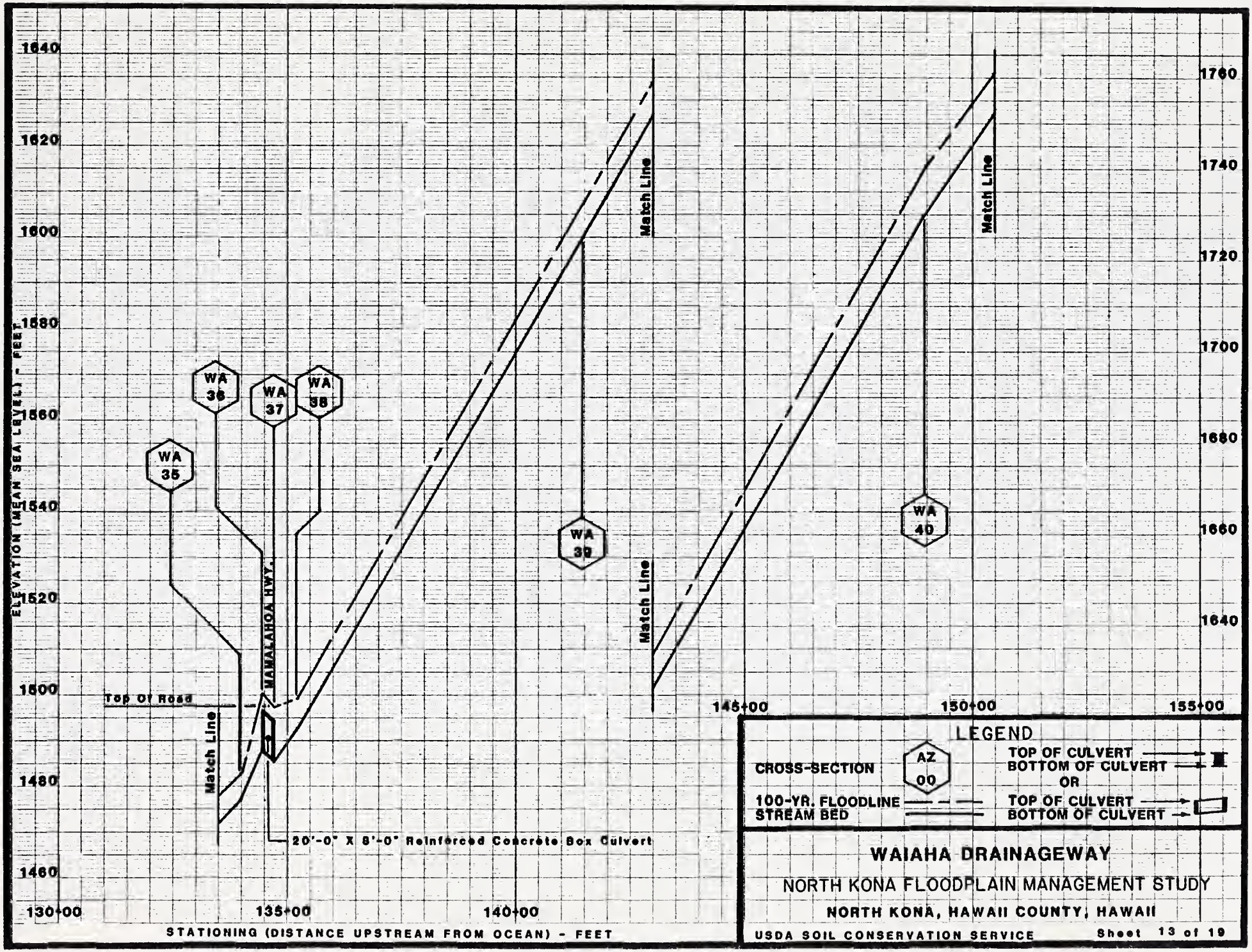
WAIAHA DRAINAGEWAY

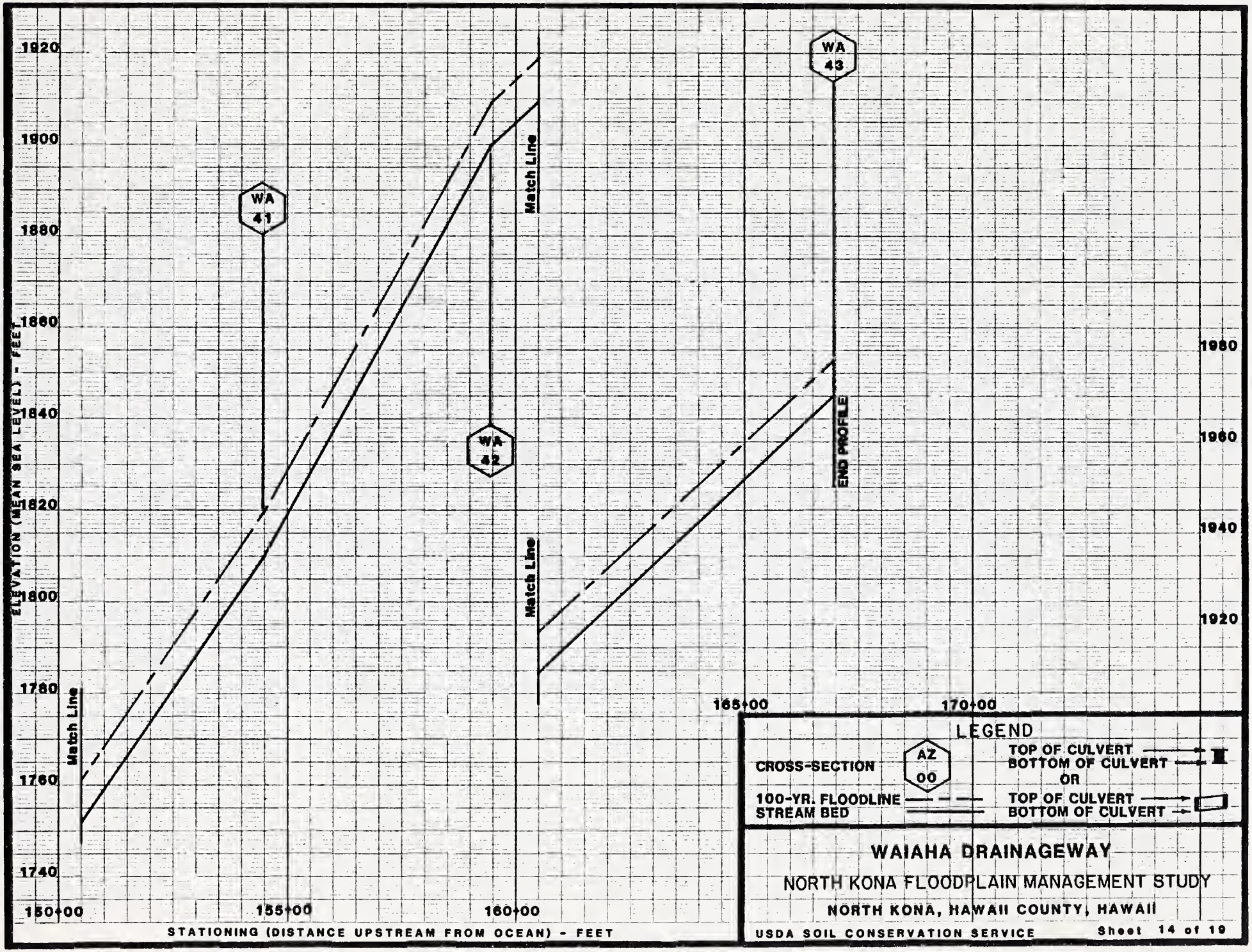
NORTH KONA FLOODPLAIN MANAGEMENT STUDY

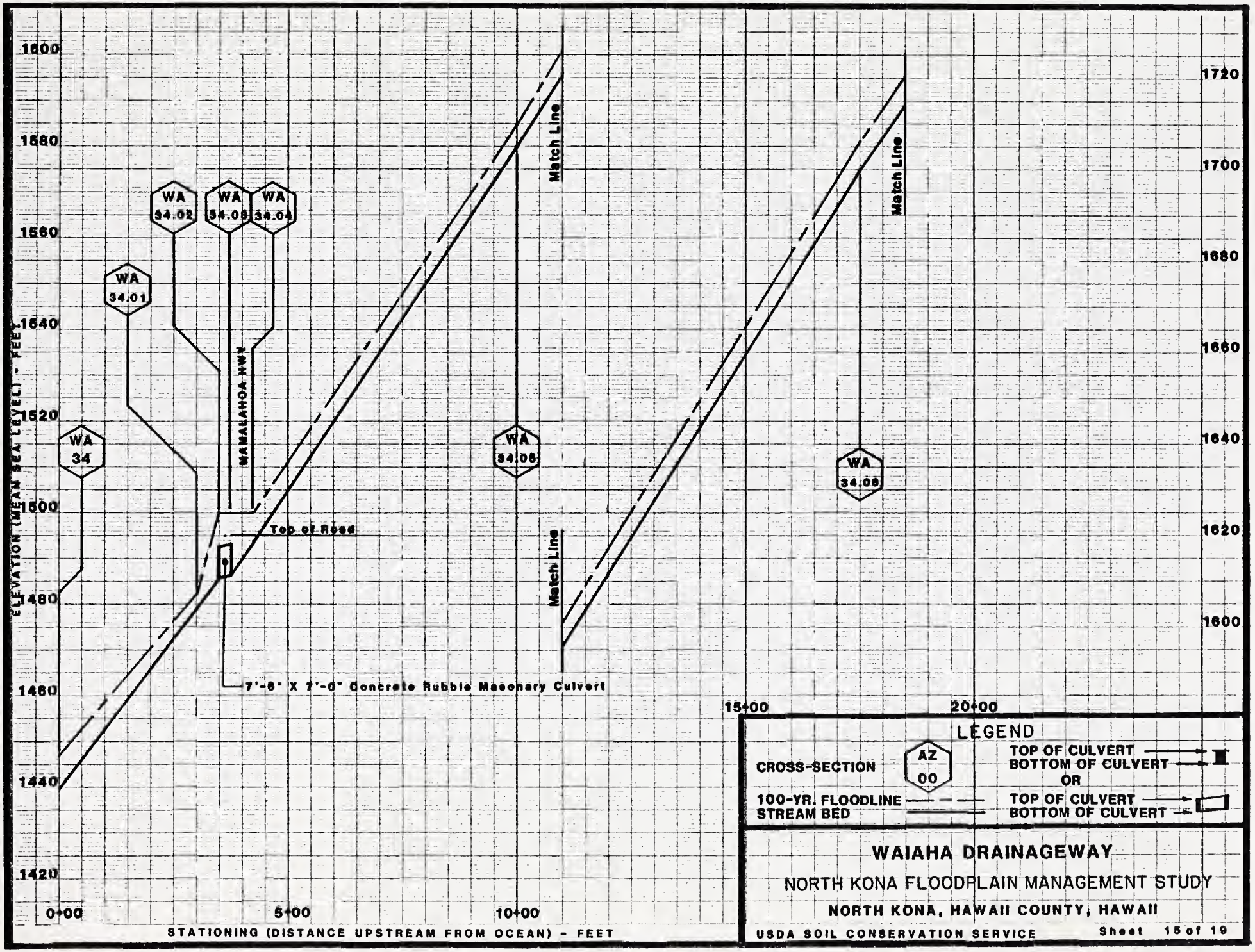
NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


1380
1360
1340
1320
1300
1280
1260
1240
1220
1200
ELEVATION (MEAN SEA LEVEL) - FEET
110+00
115+00
120+00
125+00
130+00
135+00
1480
1460
1440
1420
1400
1380
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
Match Line
Match Line
Match Line
Match Line
WA 32
WA 33
WA 34
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
WAIAHA DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 12 of 19


1640
1620
1600
1580
1560
1540
1520
1500
1480
1460
ELEVATION (MEAN SEA LEVEL) - FEET
WA 35
WA 36
WA 37
WA 38
WA 39
WA 40
MAMALAHOA HWY.
Top Of Road
Match Line
Match Line
Match Line
Match Line
20'-0" X 8'-0" Reinforced Concrete Box Culvert
130+00
135+00
140+00
145+00
150+00
155+00
1760
1740
1720
1700
1680
1660
1640
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
WAIAHA DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 13 of 19


1920
1900
1880
1860
1840
1820
1800
1780
1760
1740
ELEVATION (MEAN SEA LEVEL) - FEET
WA 41
WA 42
WA 43
Match Line
Match Line
Match Line
END PROFILE
1980
1960
1940
1920
150+00
155+00
160+00
165+00
170+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
WAIAHA DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 14 of 19

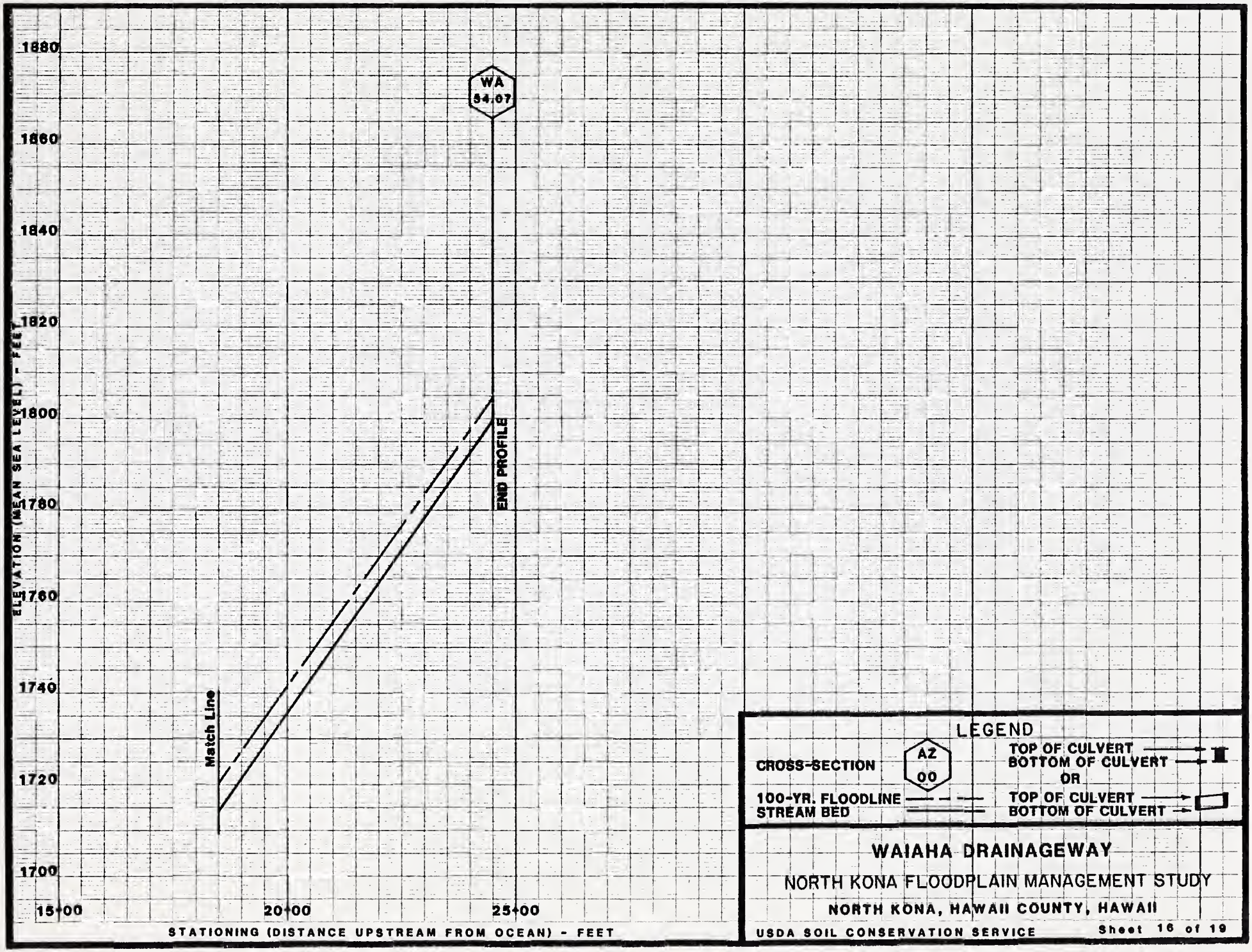


WAIAHA DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

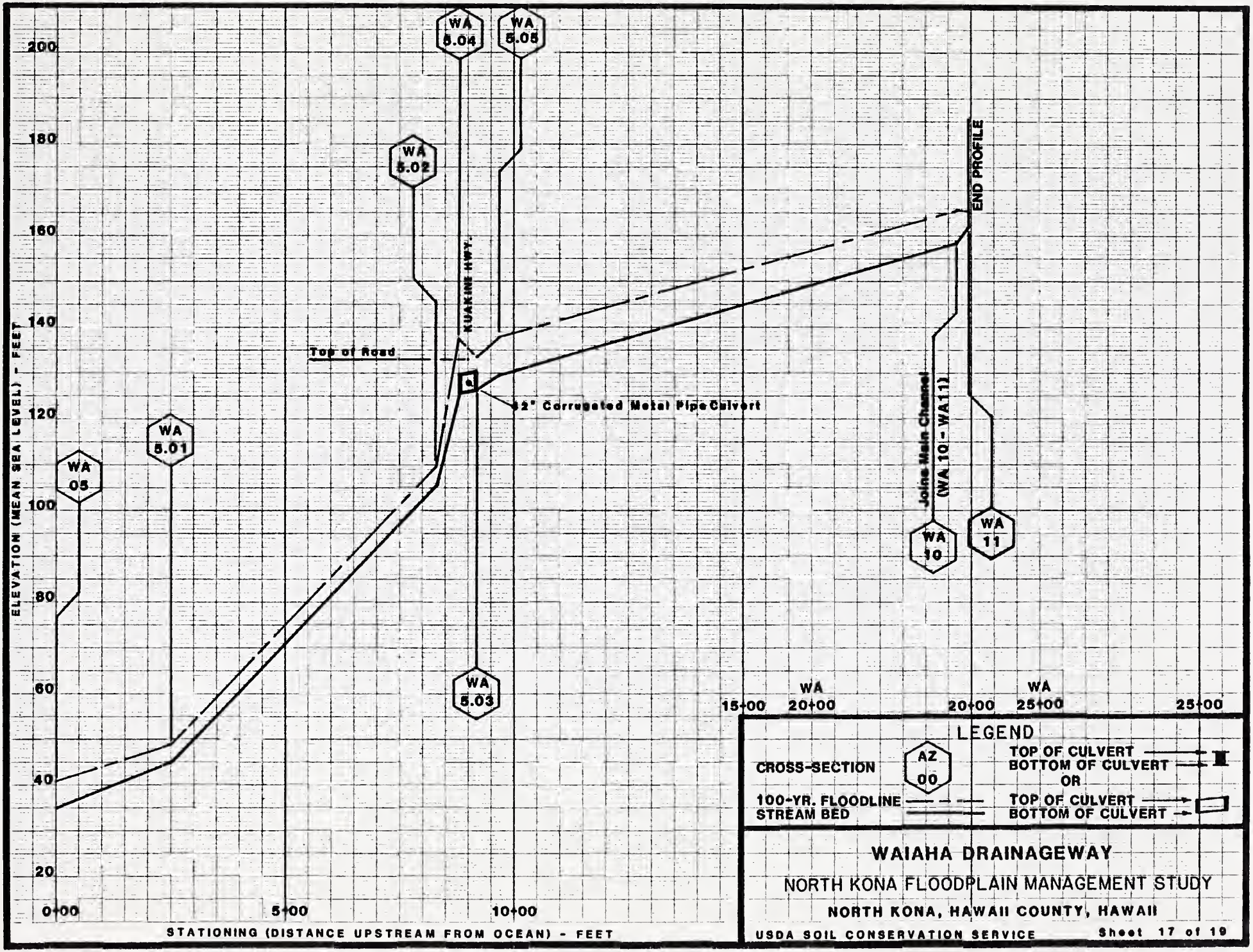


WAIAHA DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

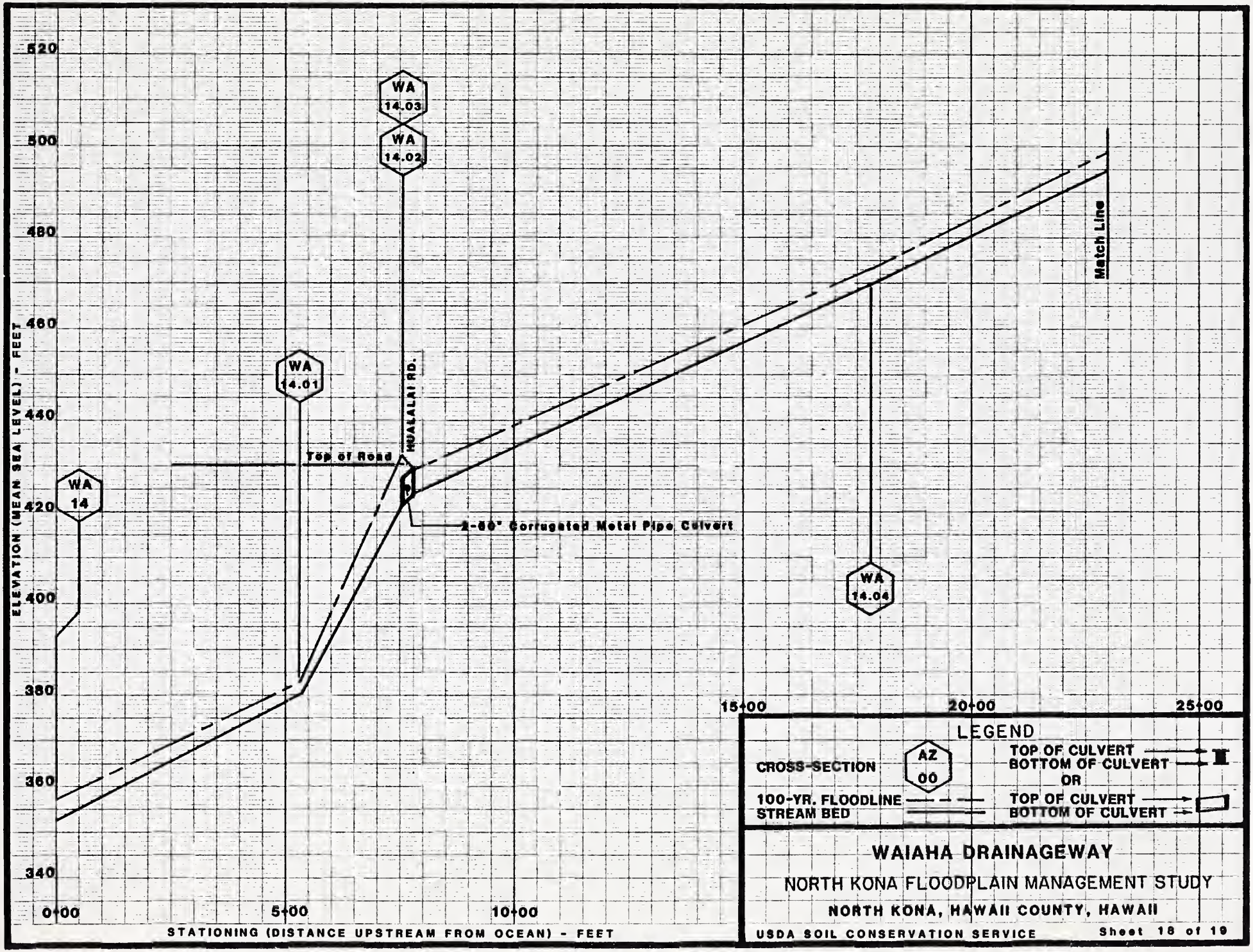


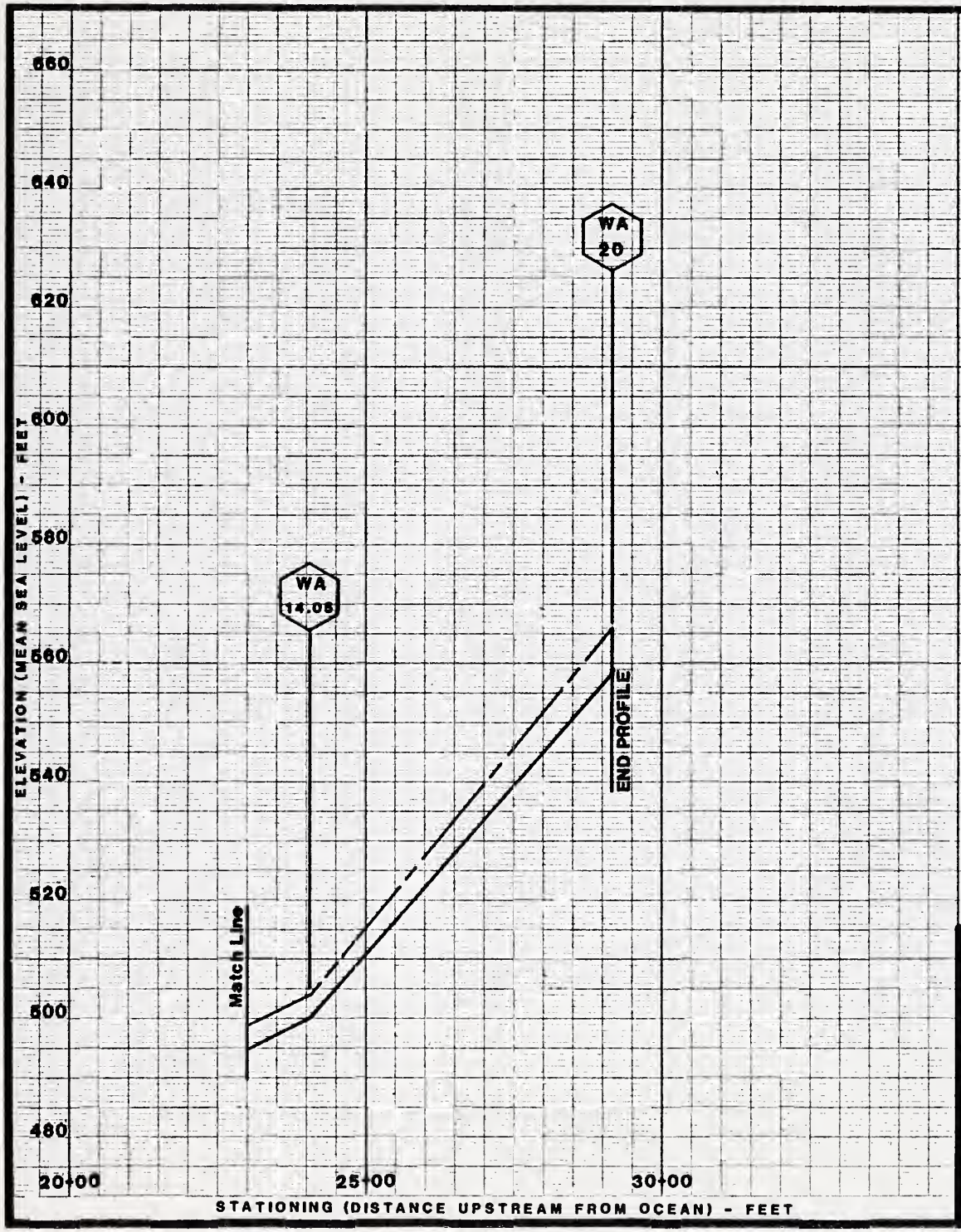
WAIAHA DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


520
500
480
460
440
420
400
380
360
340
ELEVATION (MEAN SEA LEVEL) - FEET
WA 14.03
WA 14.02
WA 14.01
WA 14
WA 14.04
HUALALAI RD.
Top of Road
2-60" Corrugated Metal Pipe Culvert
Match Line
0+00
5+00
10+00
15+00
20+00
25+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
WAIAHA DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 18 of 19



LEGEND

CROSS-SECTION — AZ / 00

100-YR. FLOODLINE

STREAM BED

TOP OF CULVERT

BOTTOM OF CULVERT

OR

TOP OF CULVERT

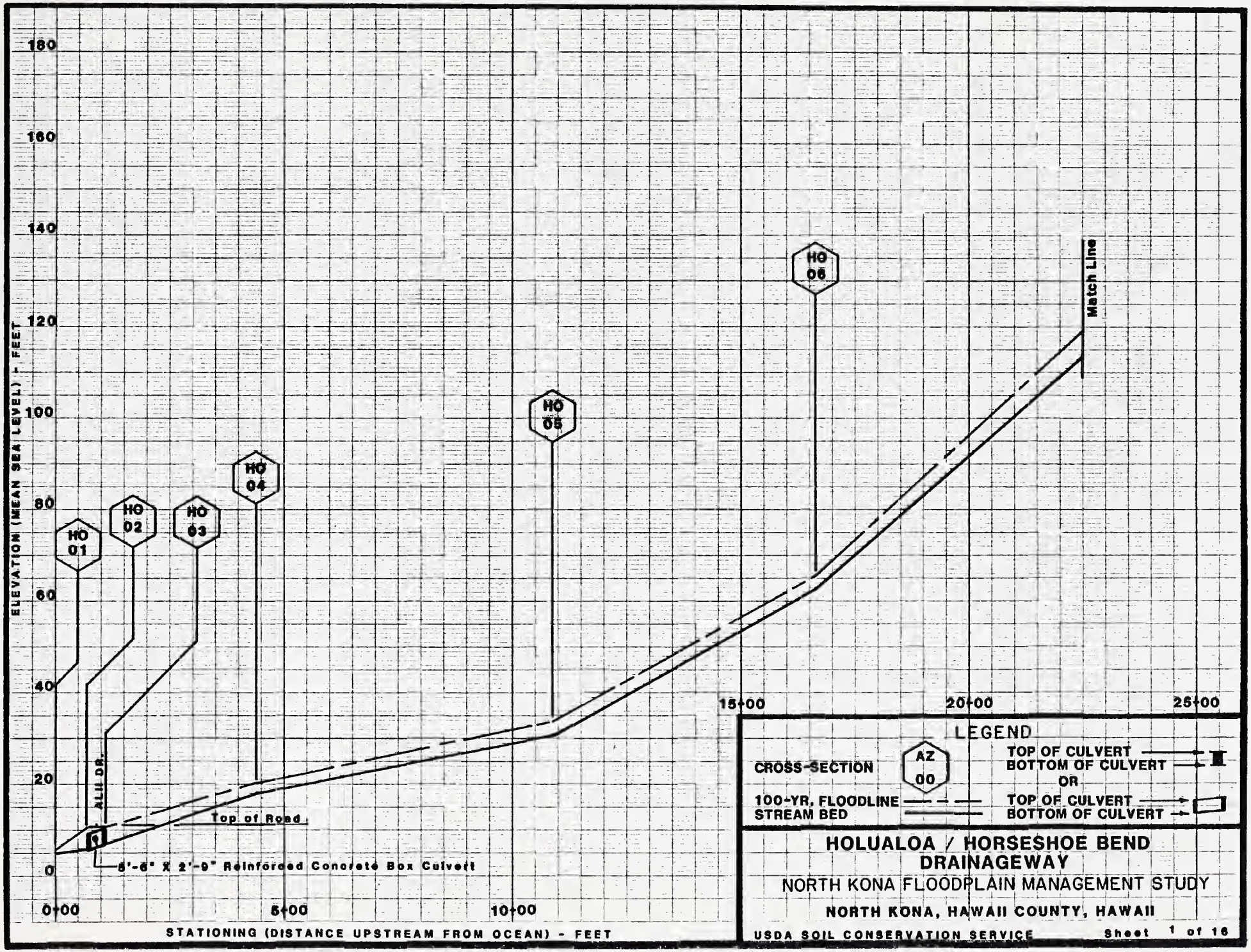
BOTTOM OF CULVERT

WAIAHA DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

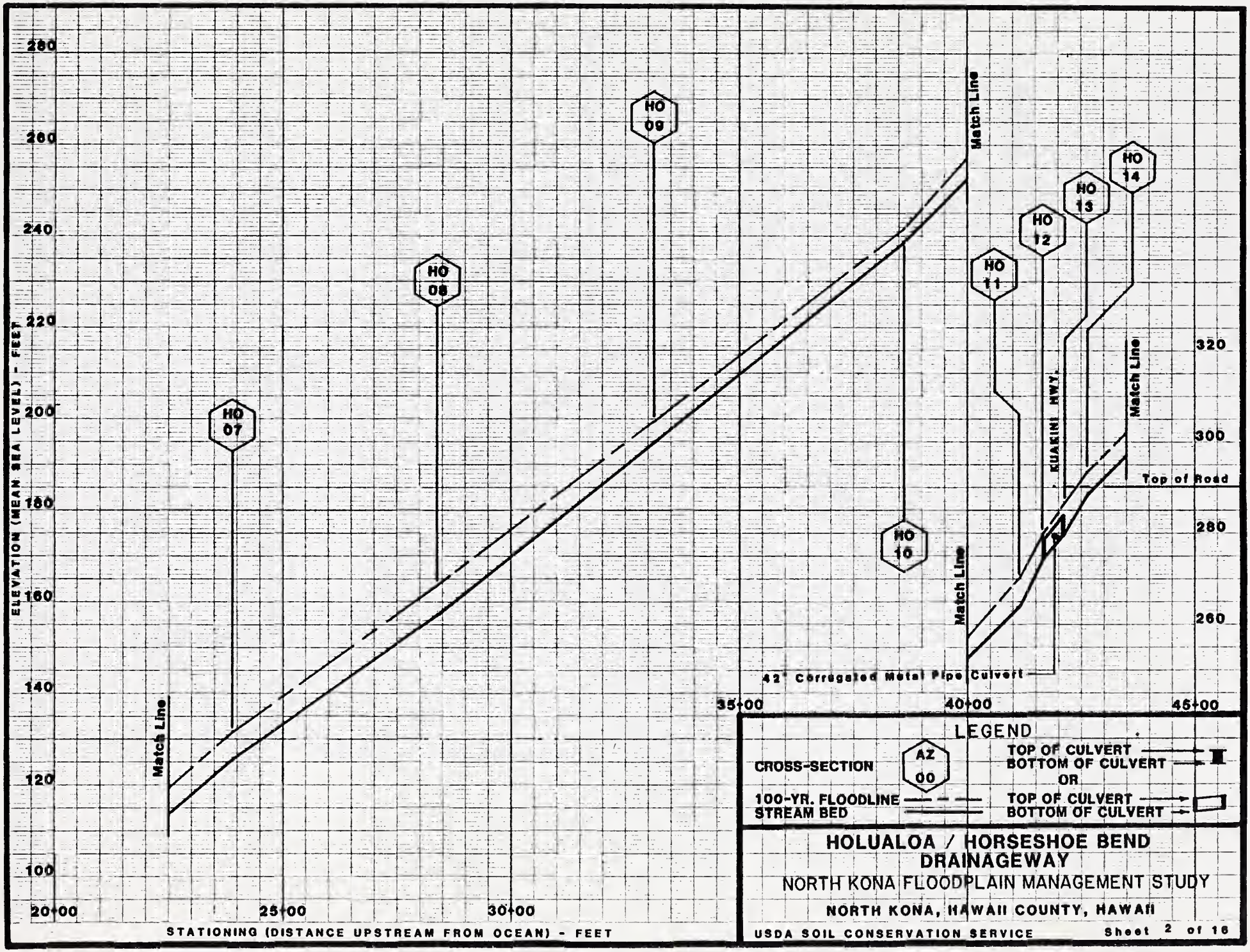


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

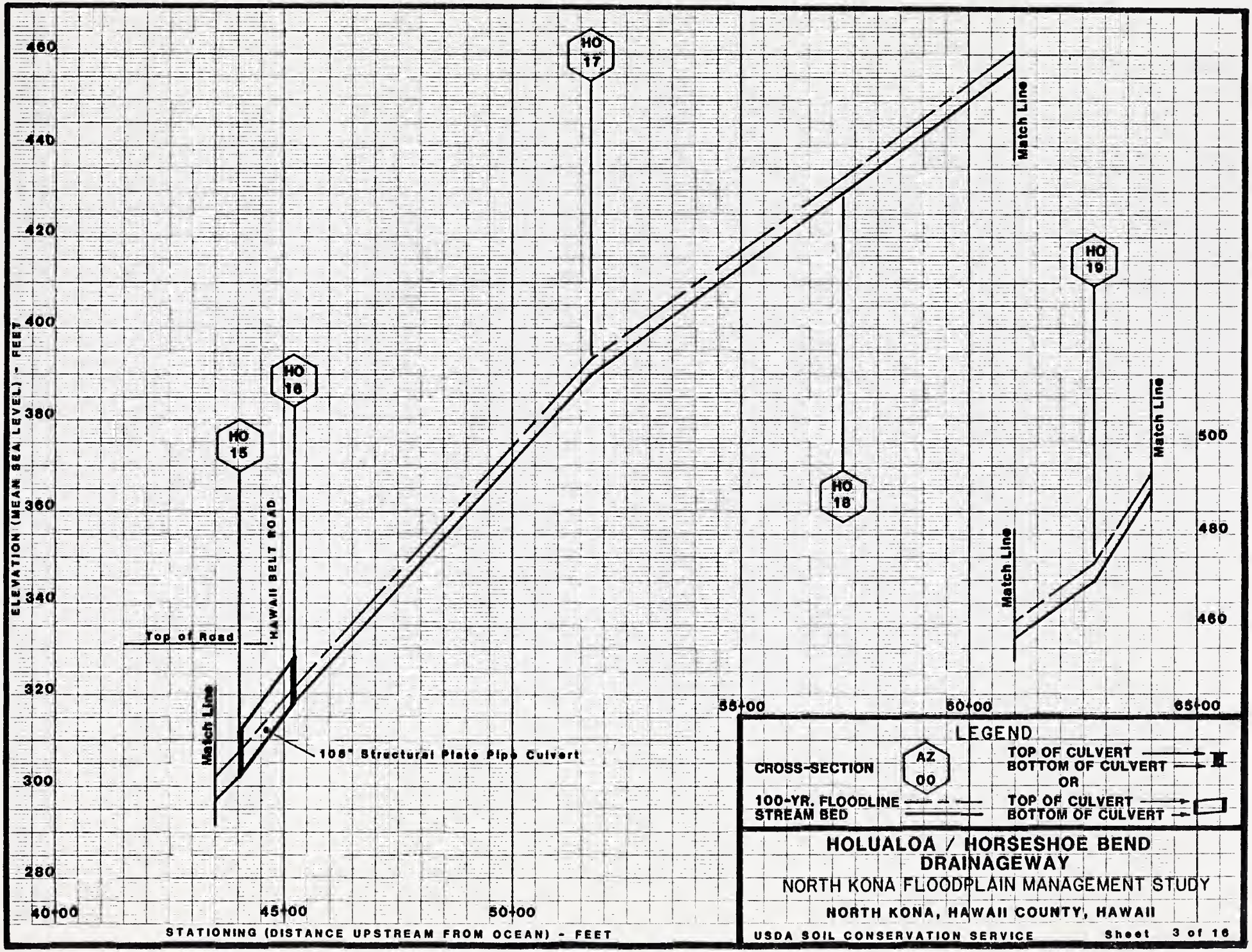


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

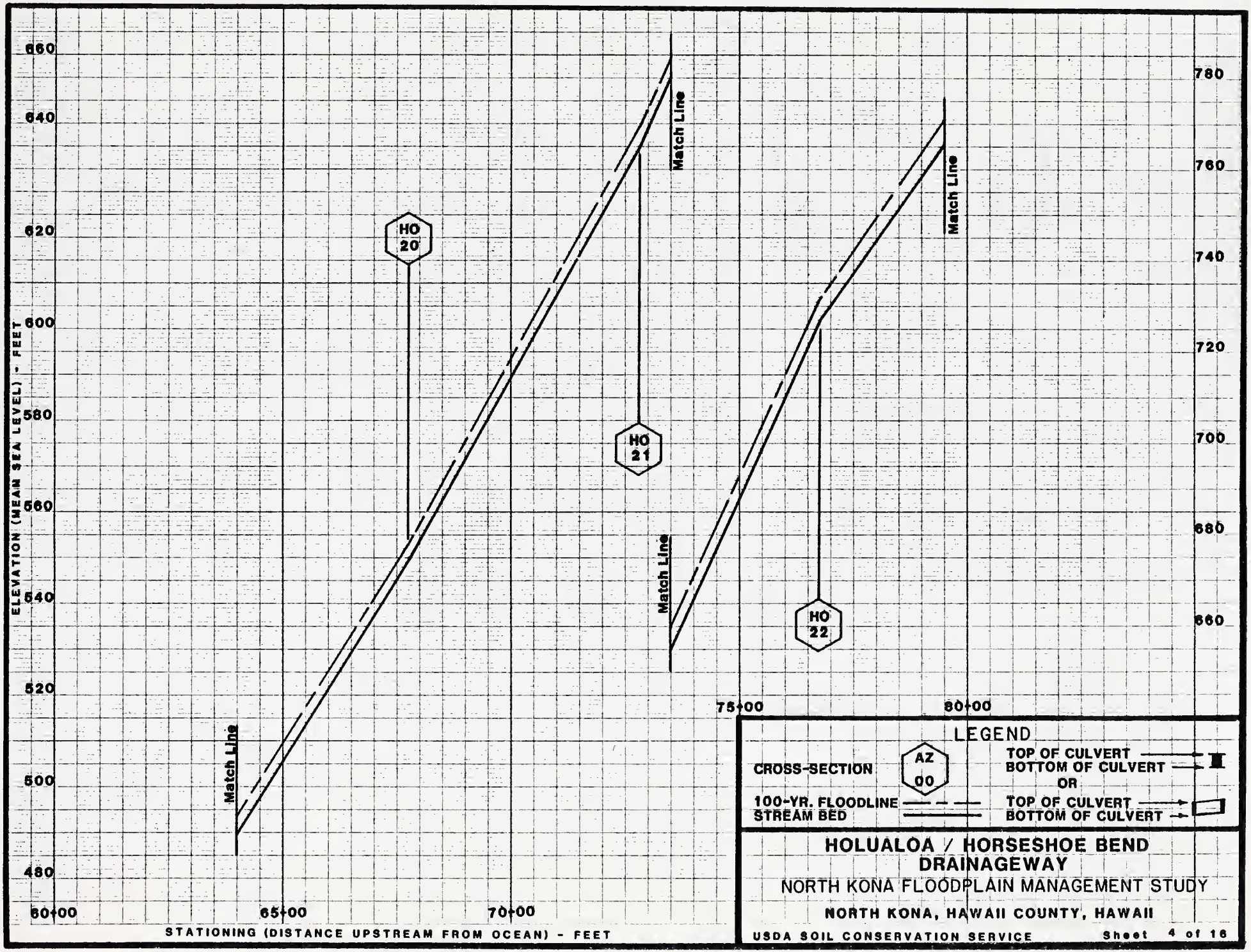


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

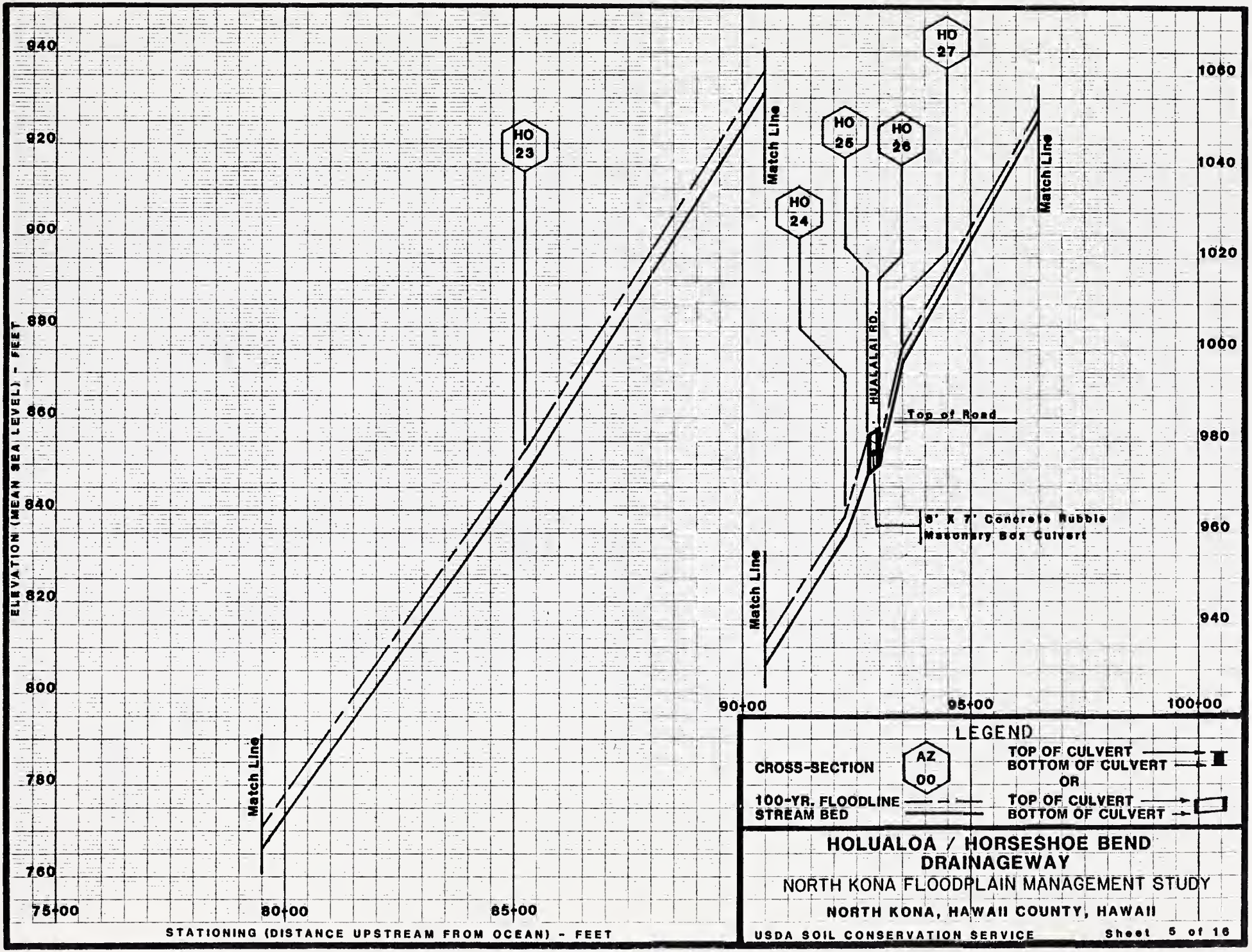


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

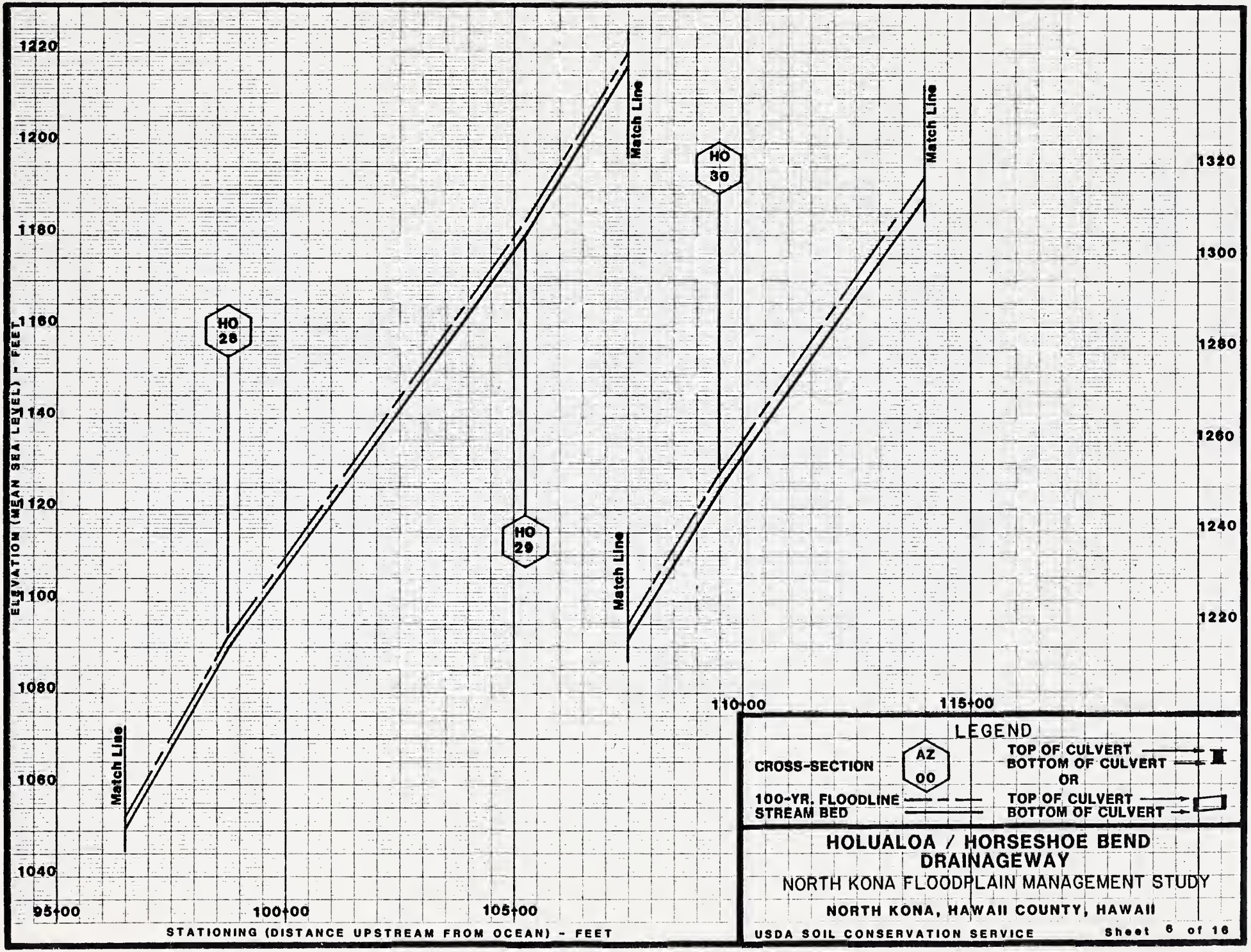


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

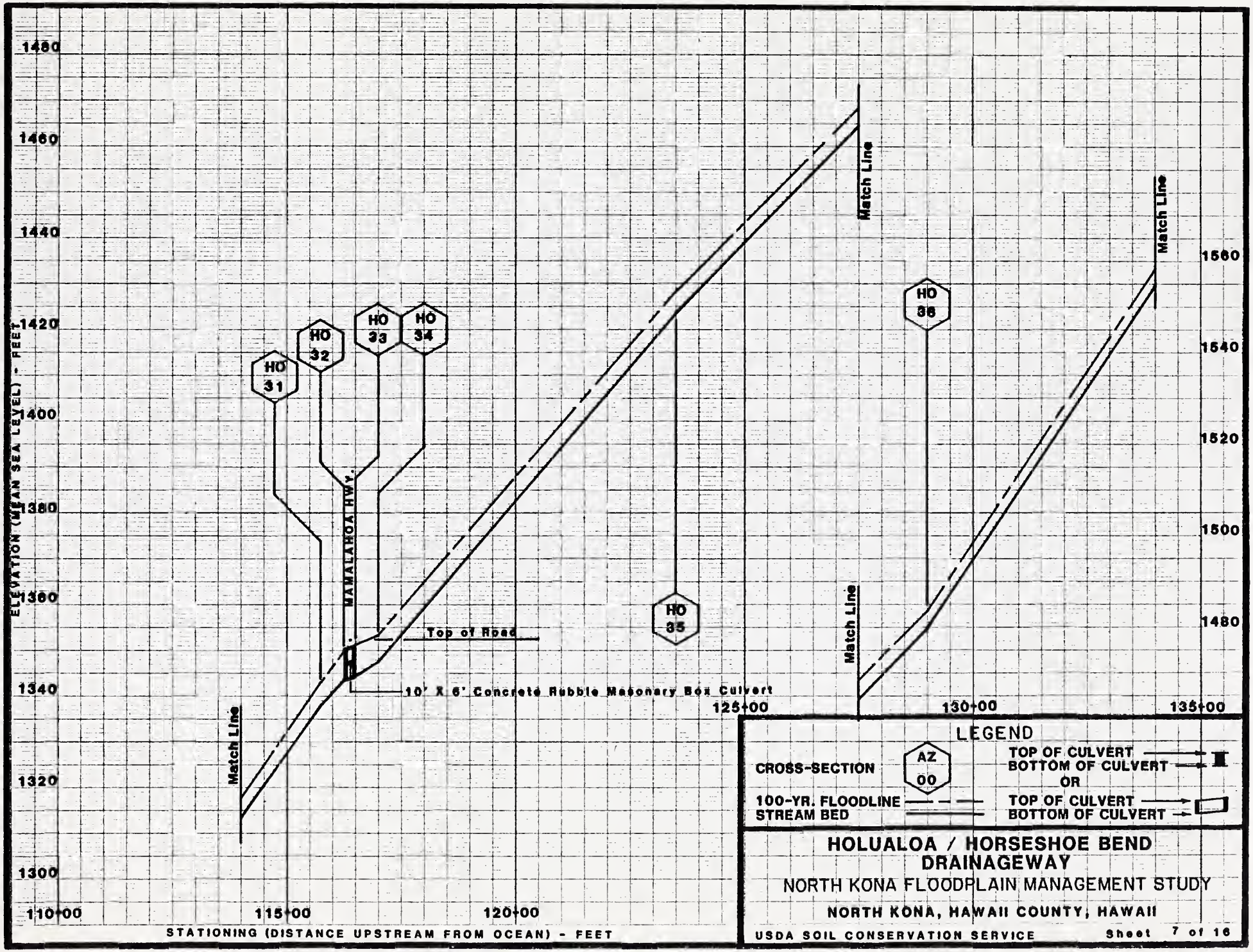


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

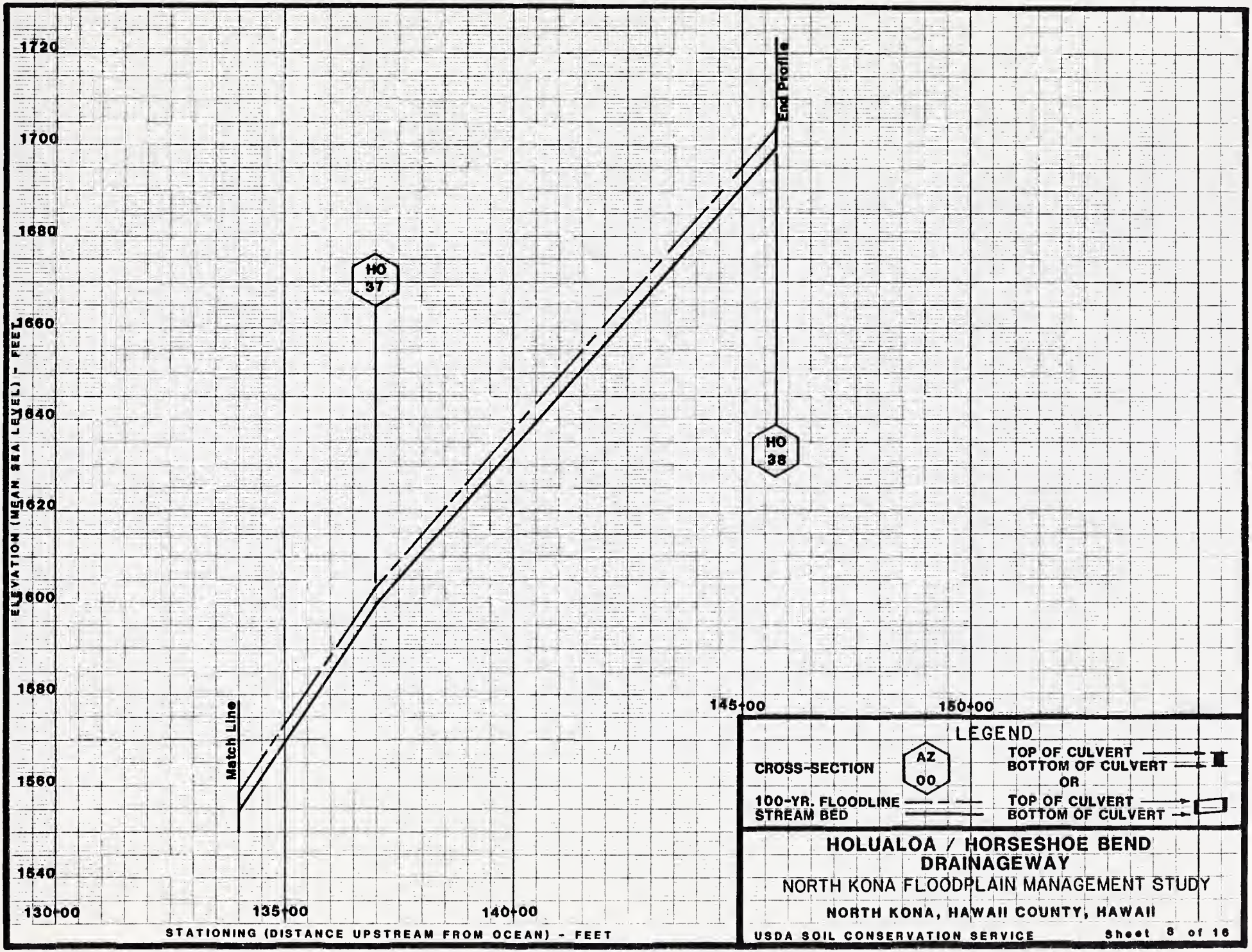


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

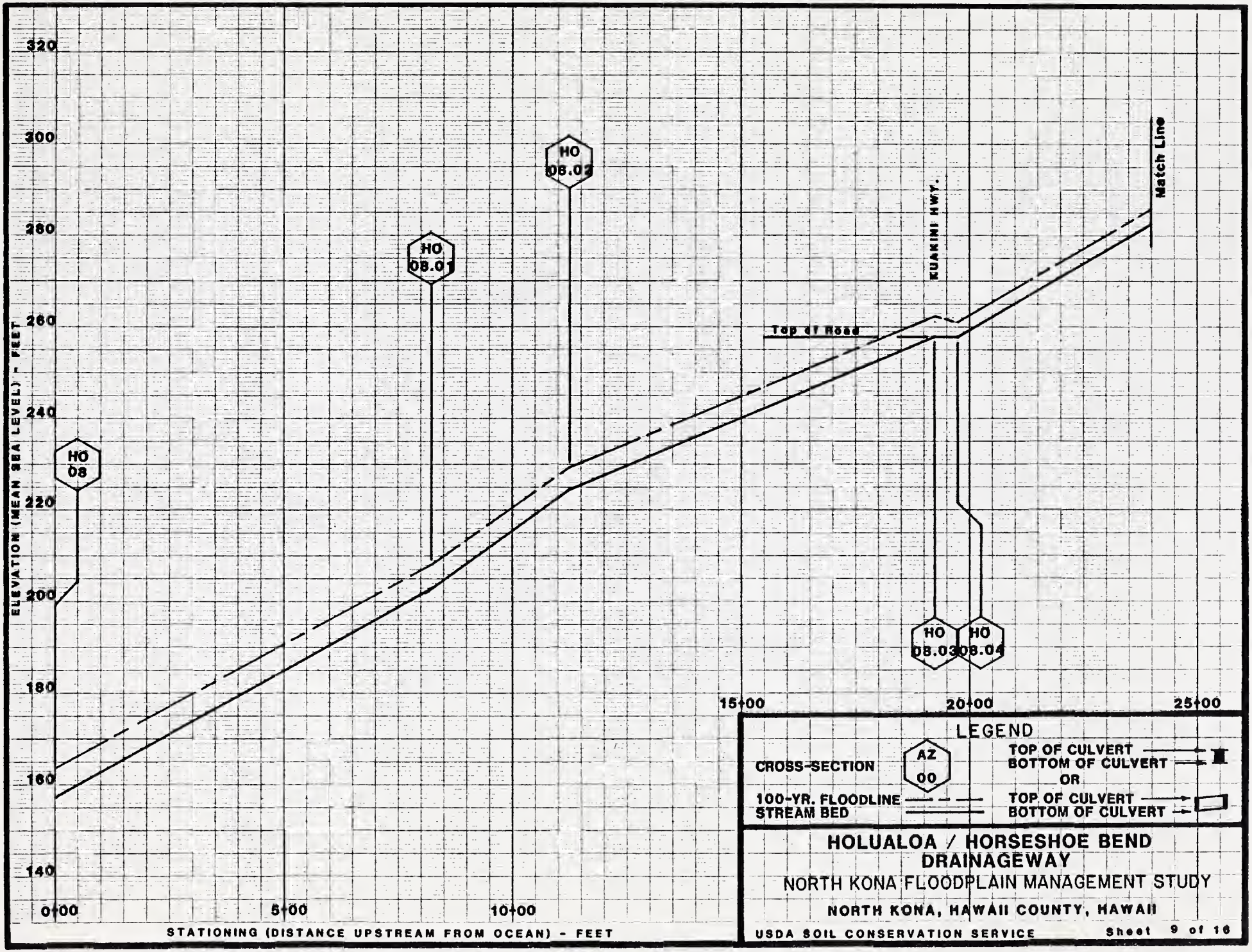


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

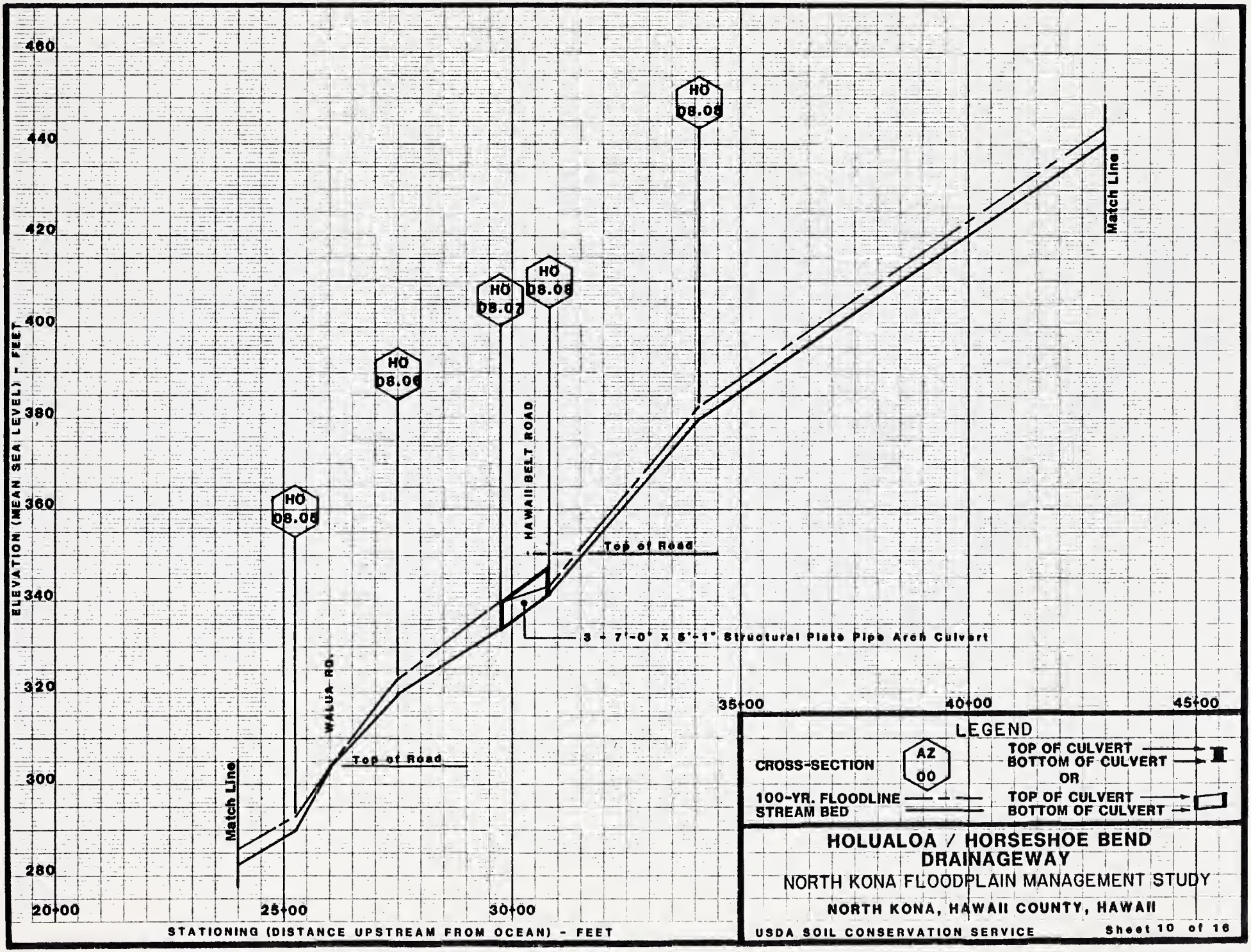


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

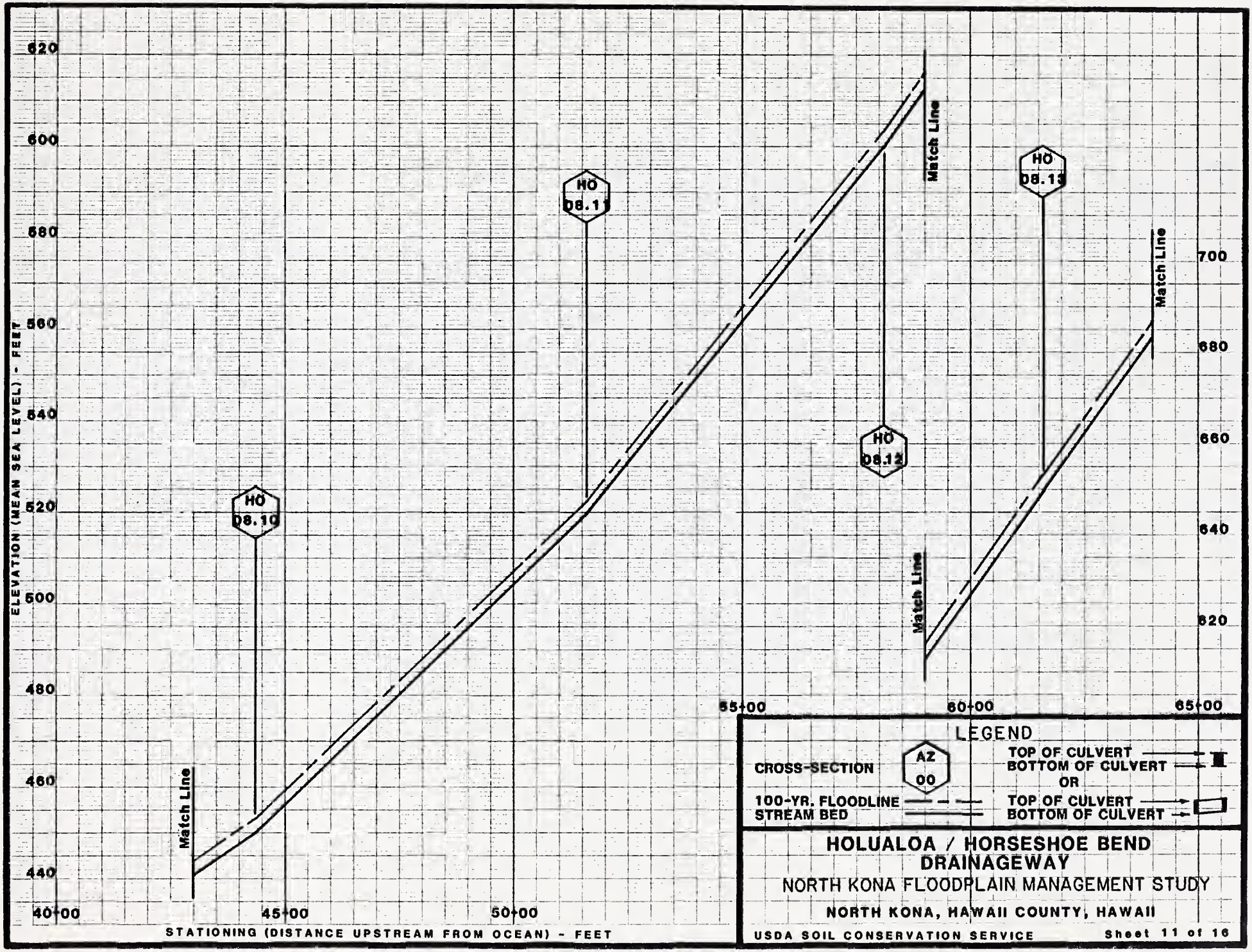


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

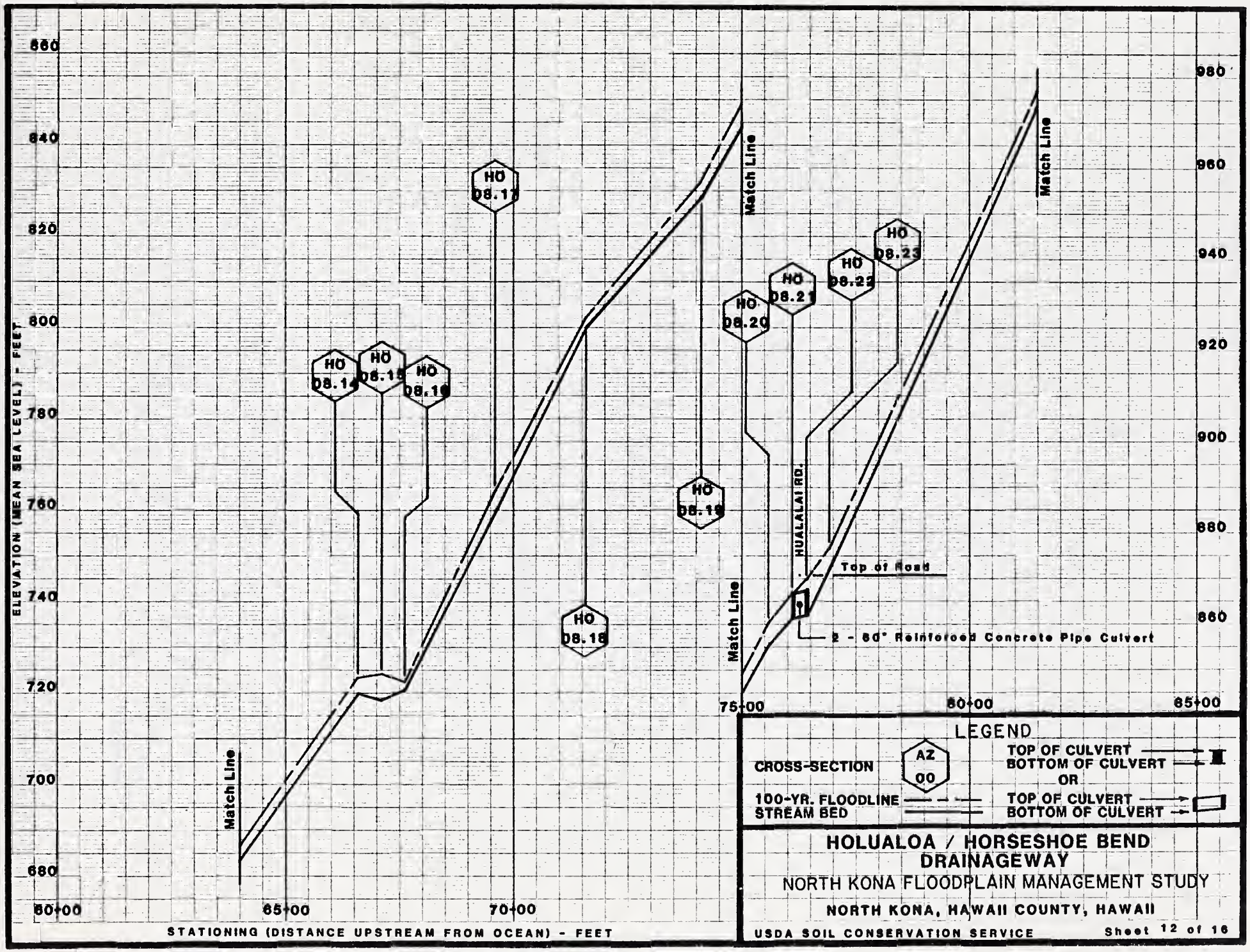


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

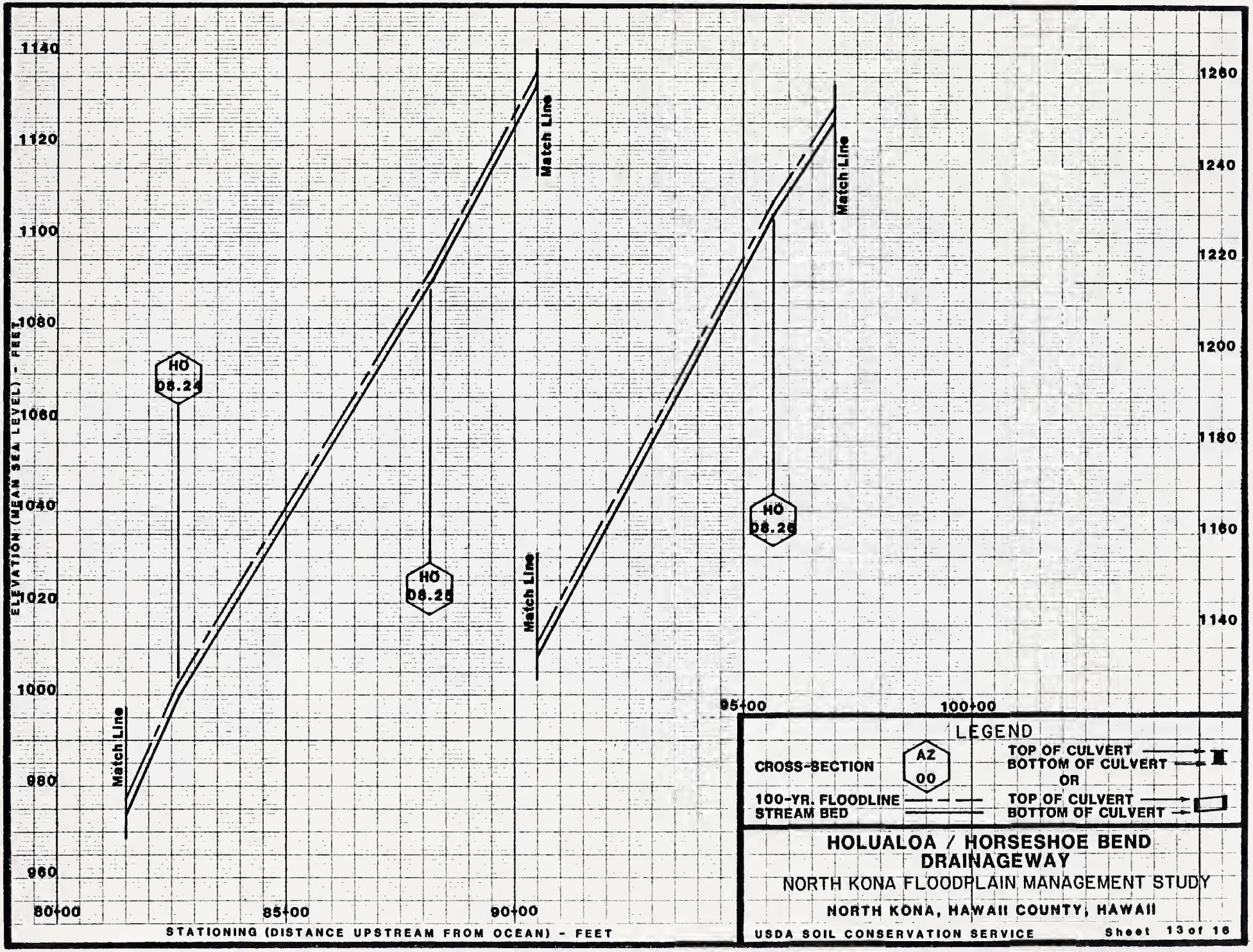


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

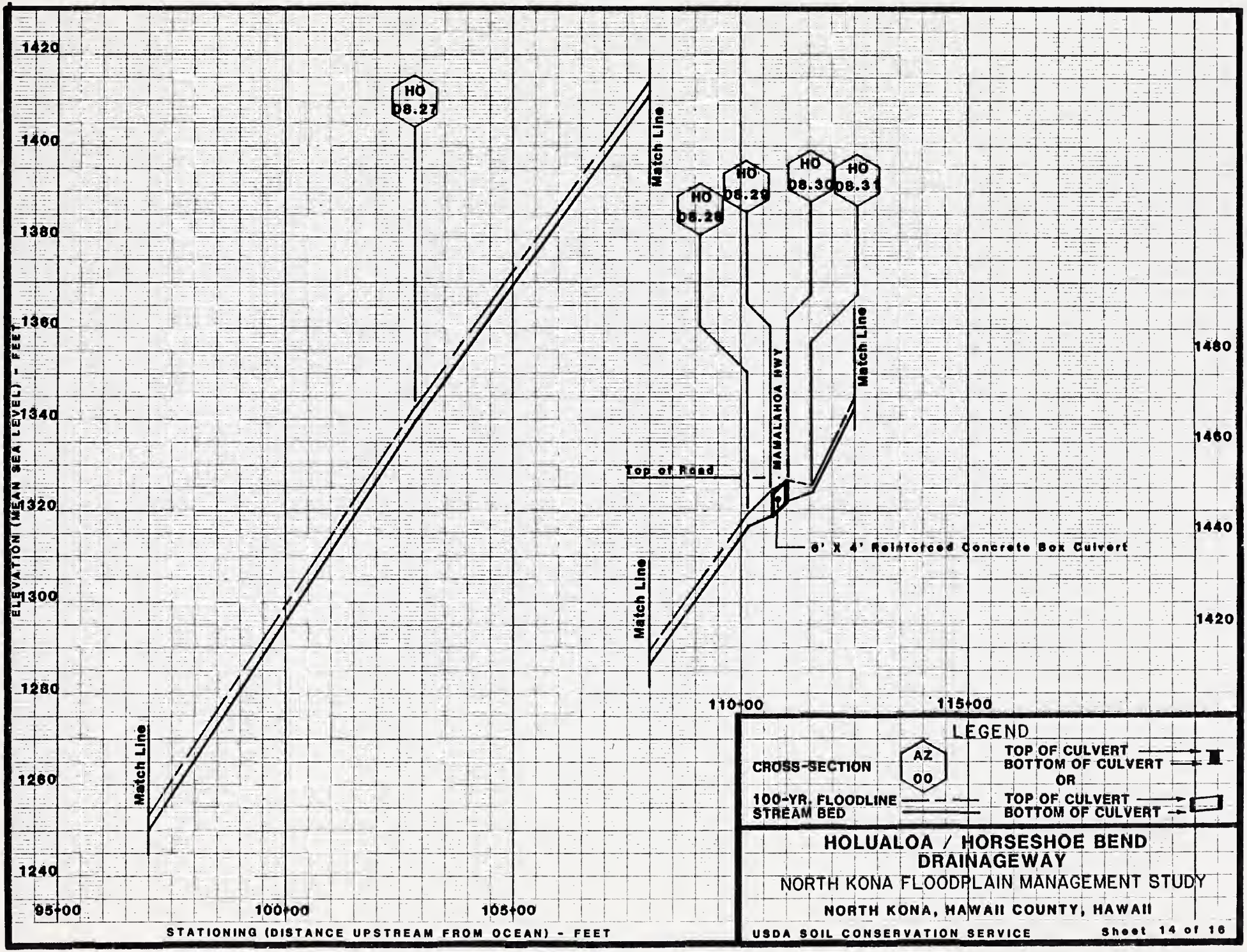


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

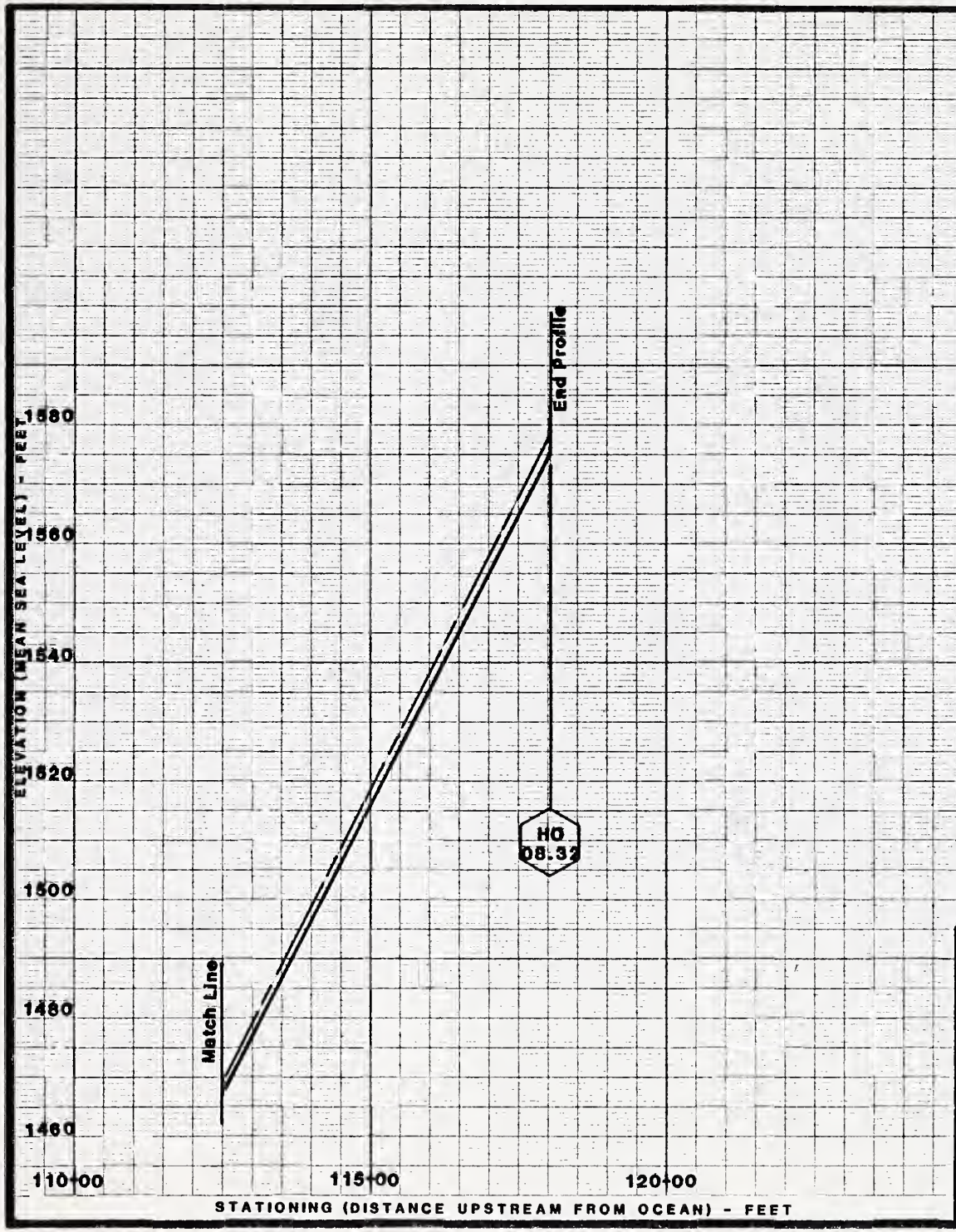


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE



LEGEND

CROSS-SECTION — AZ / 00

100-YR. FLOODLINE

STREAM BED

TOP OF CULVERT

BOTTOM OF CULVERT

OR

TOP OF CULVERT

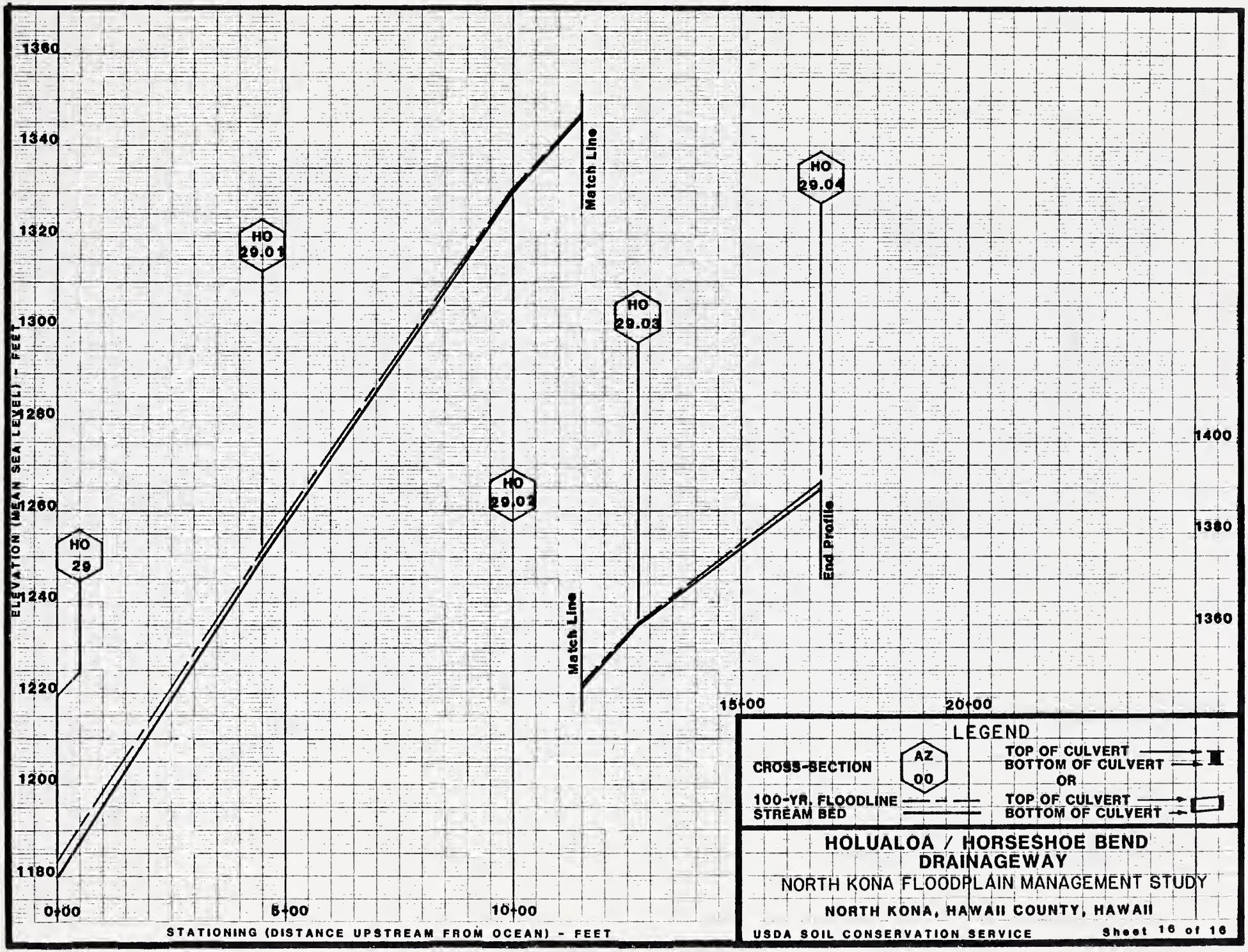
BOTTOM OF CULVERT

HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

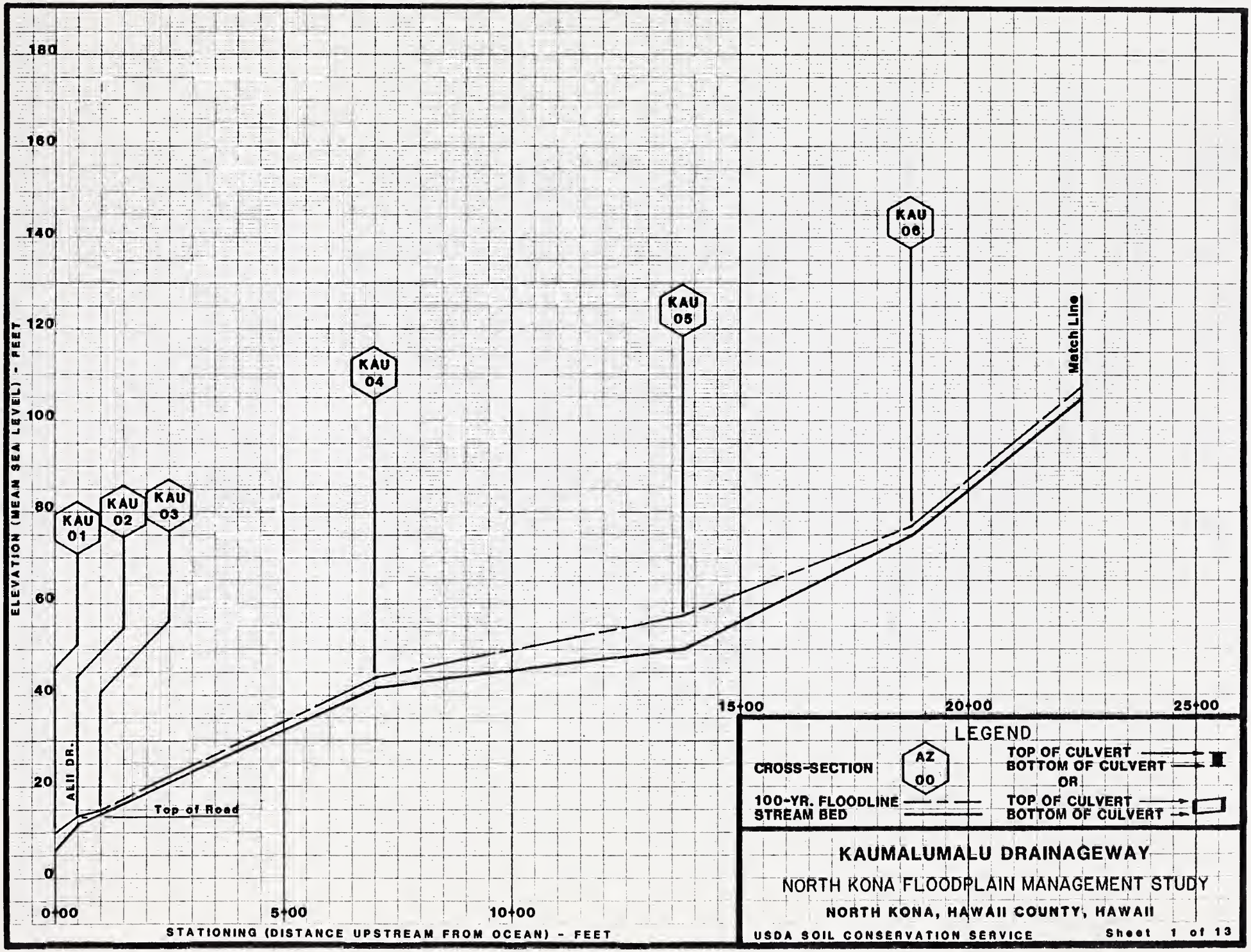


HOLUALOA / HORSESHOE BEND DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

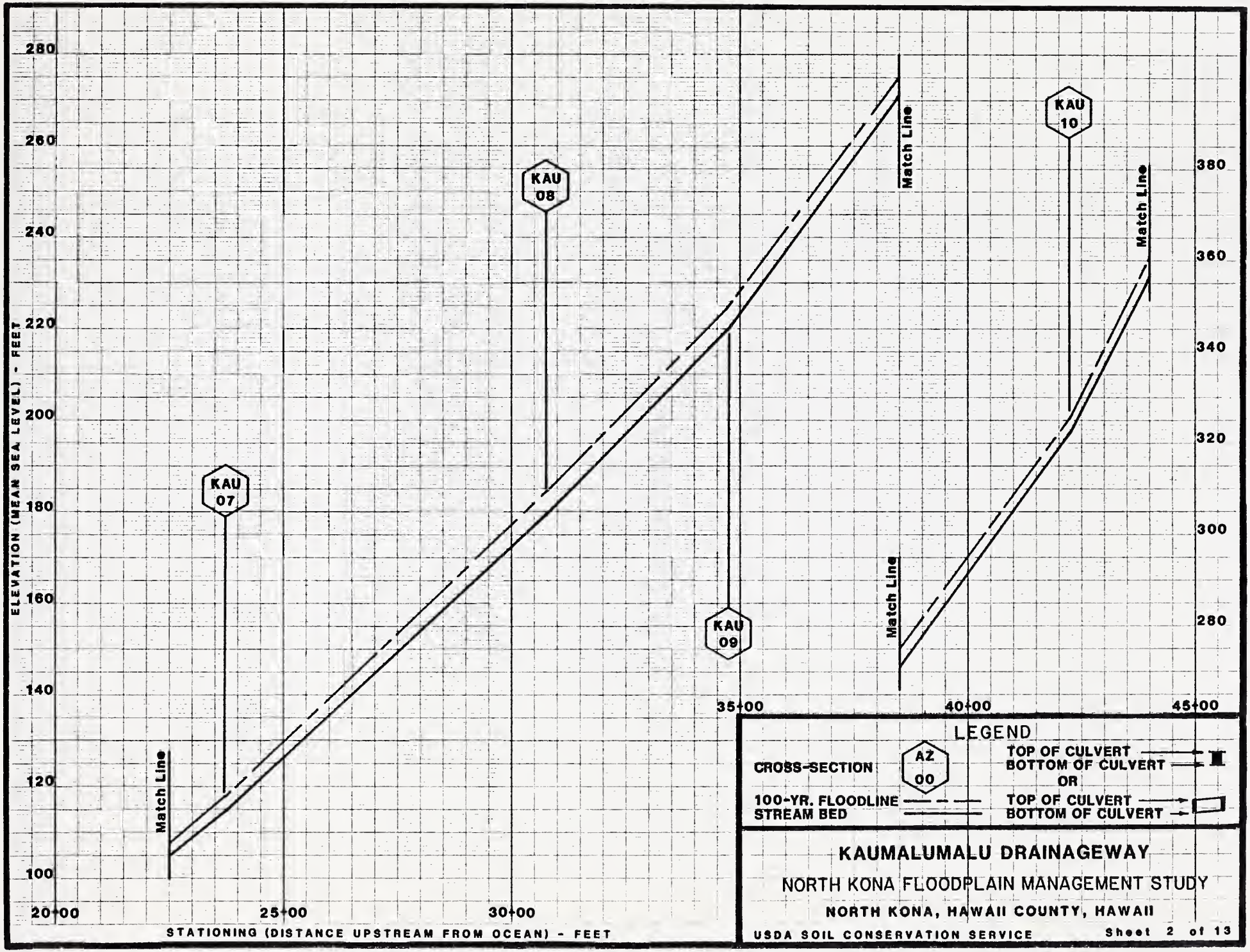


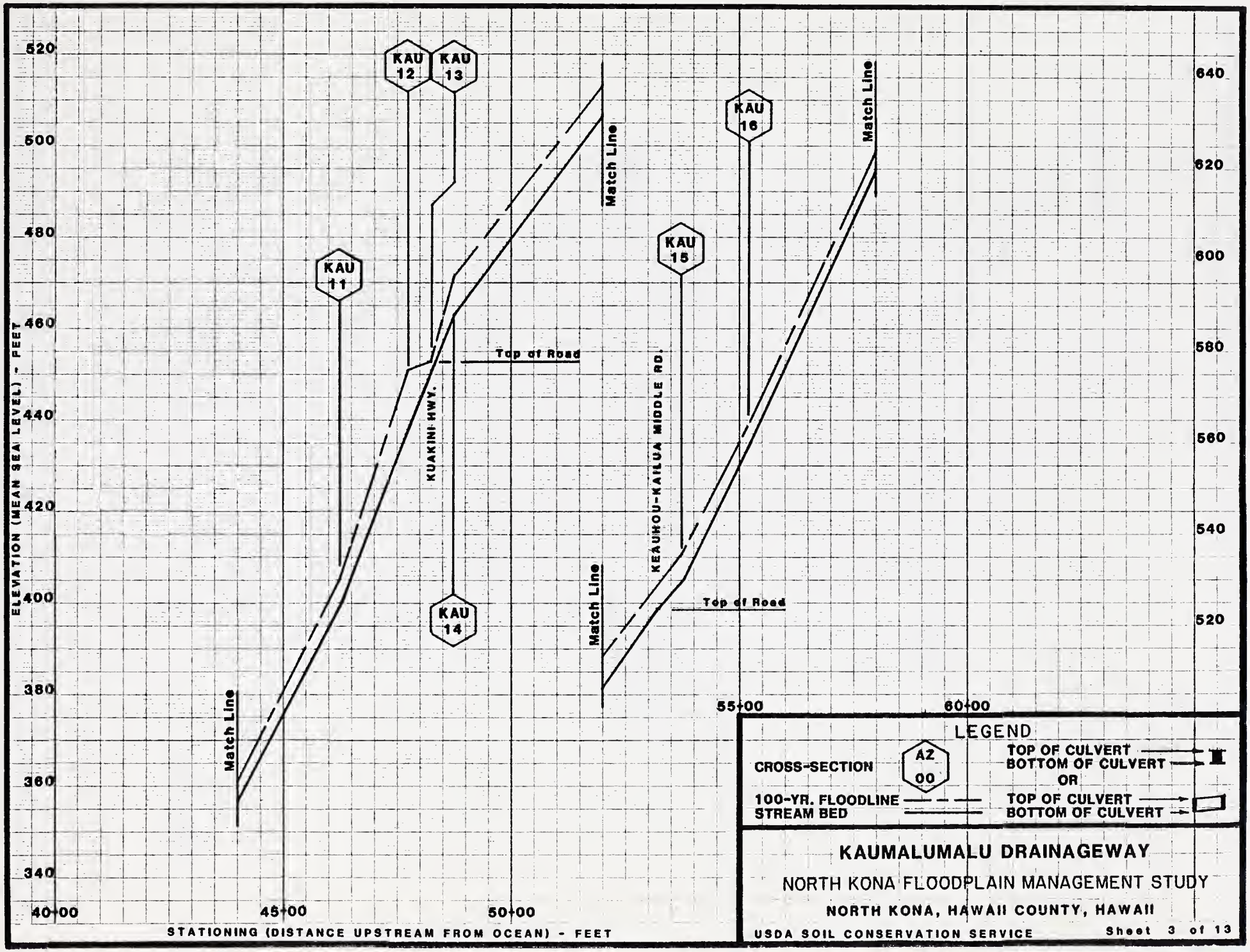
KAUMALUMALU DRAINAGEWAY

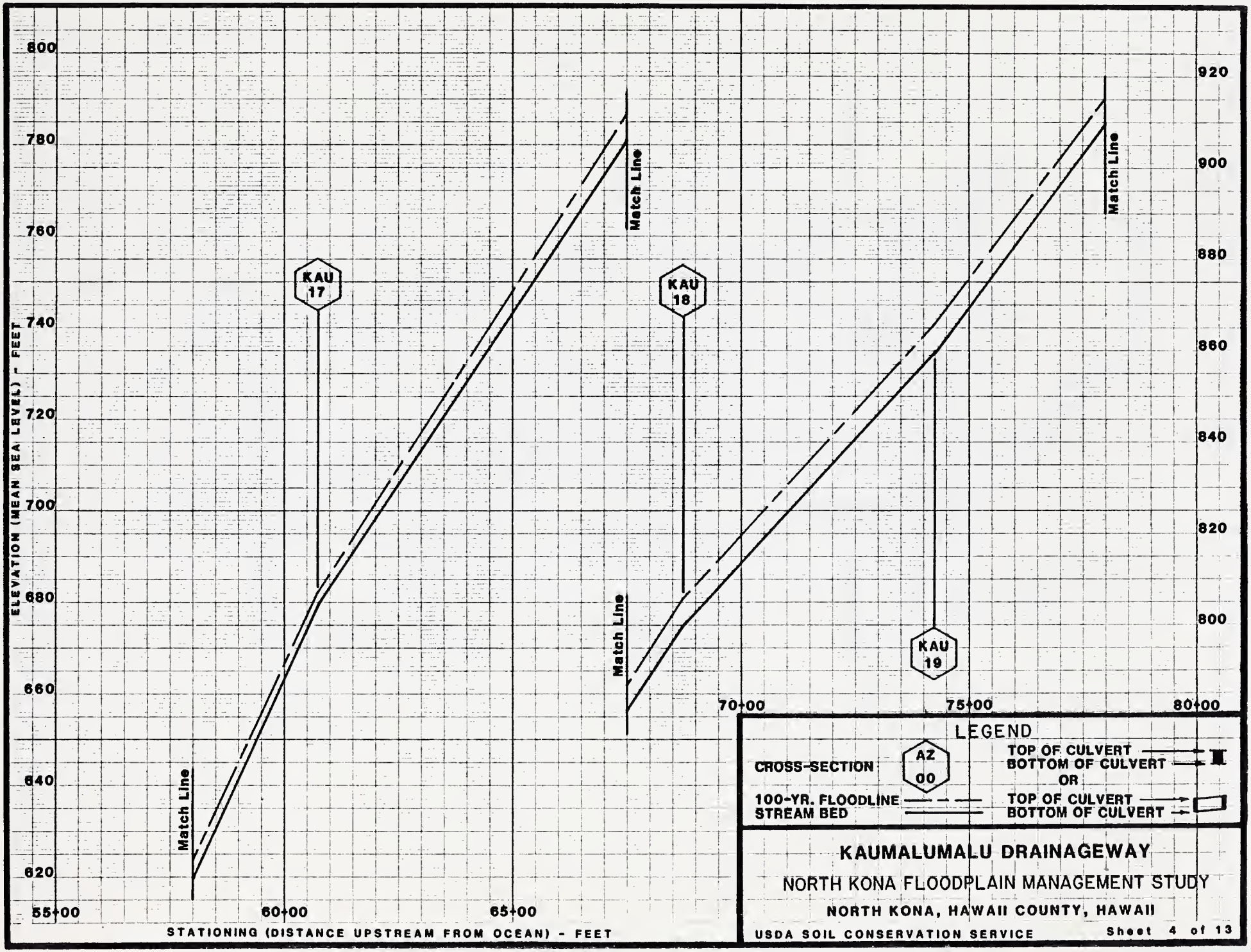
NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


280
260
240
220
200
180
160
140
120
100
ELEVATION (MEAN SEA LEVEL) - FEET
380
360
340
320
300
280
KAU 07
KAU 08
KAU 09
KAU 10
Match Line
Match Line
Match Line
Match Line
20+00
25+00
30+00
35+00
40+00
45+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAUMALUMALU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 2 of 13


520
500
480
460
440
420
400
380
360
340
ELEVATION (MEAN SEA LEVEL) - FEET
640
620
600
580
560
540
520
KAU 12
KAU 13
KAU 11
KAU 14
KAU 15
KAU 16
Match Line
Match Line
Match Line
Match Line
Top of Road
Top of Road
KUAKINI HWY.
KEAUHOU-KAILUA MIDDLE RD.
40+00
45+00
50+00
55+00
60+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAUMALUMALU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 3 of 13

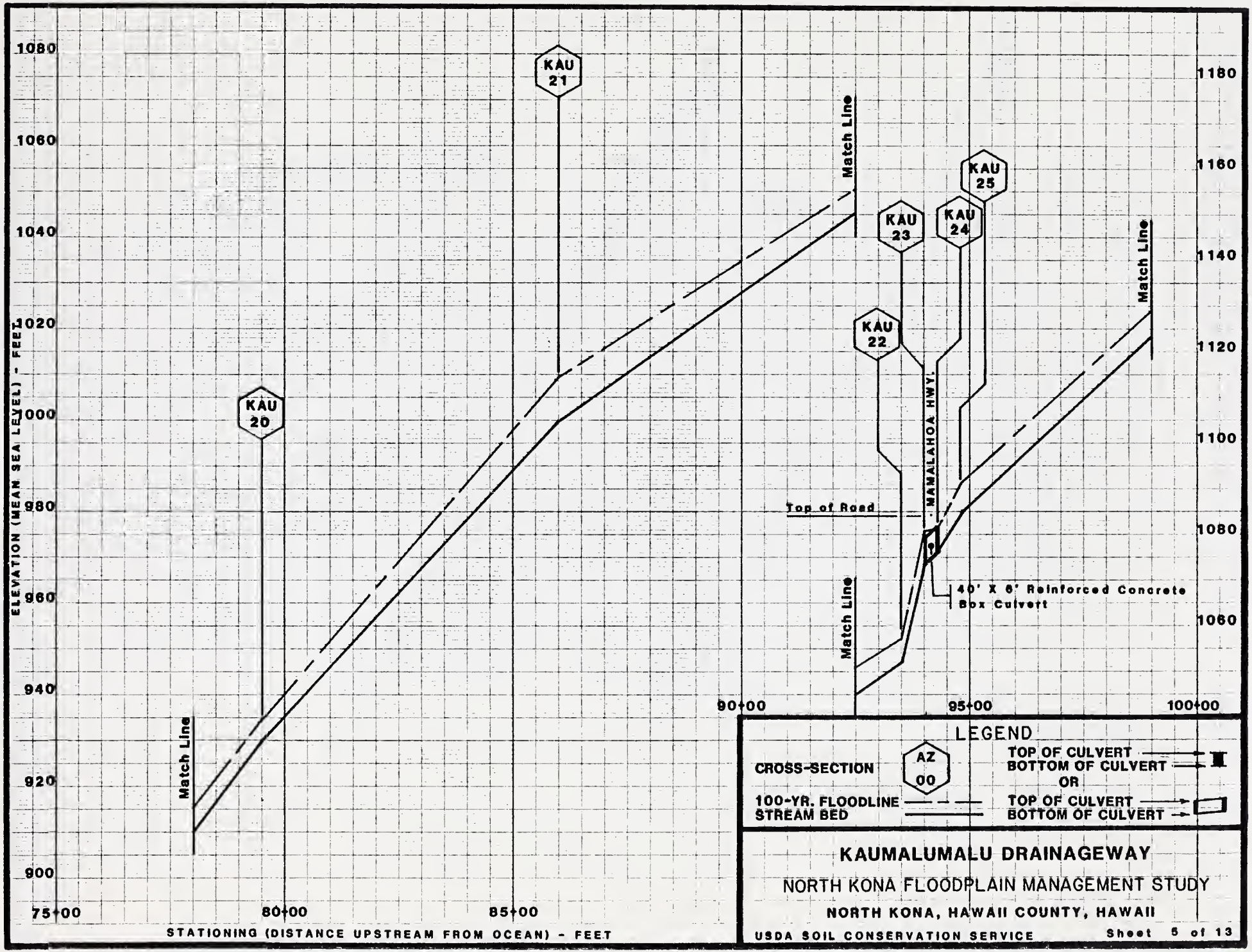


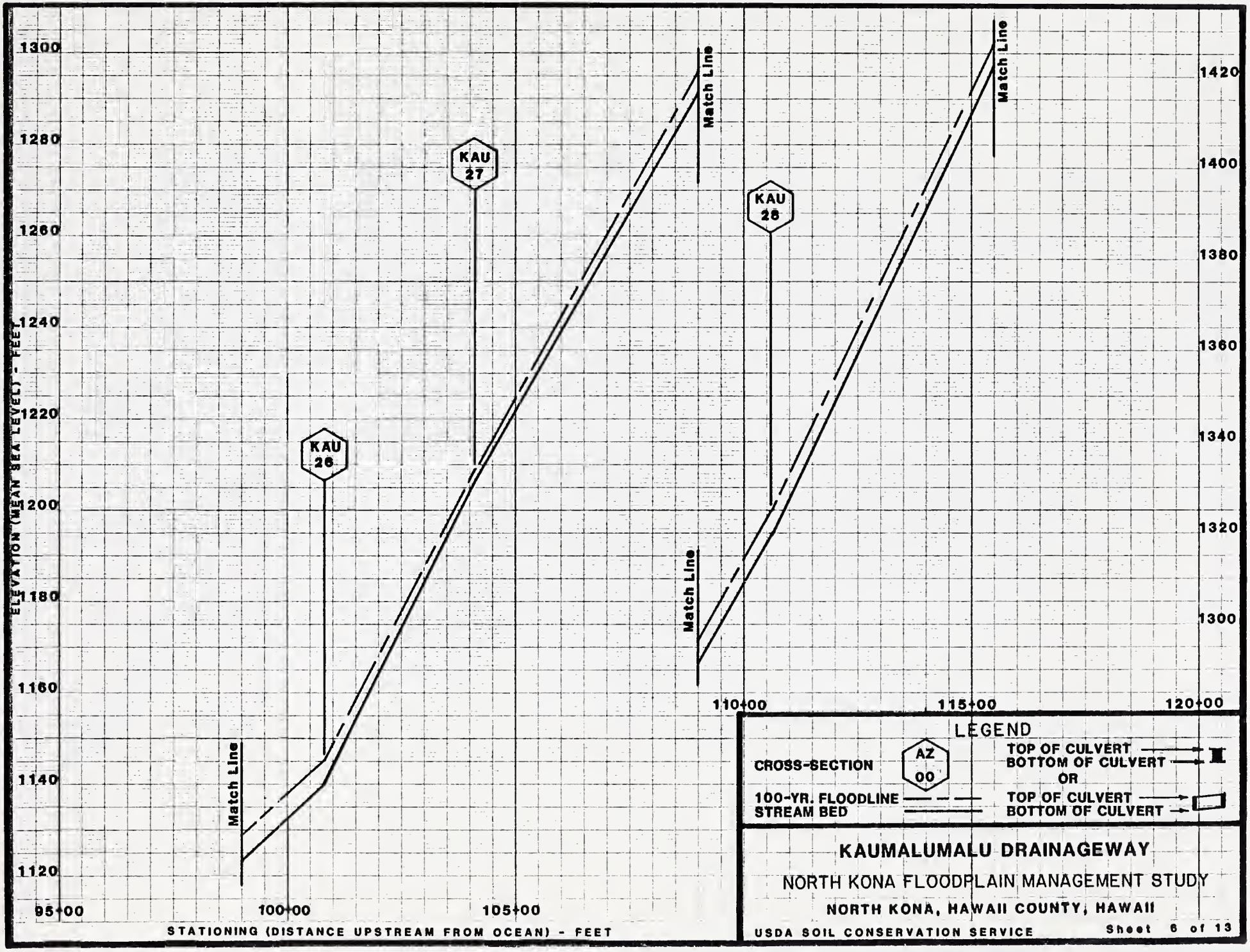
KAUMALUMALU DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


1080
1060
1040
1020
1000
980
960
940
920
900
ELEVATION (MEAN SEA LEVEL) - FEET
75+00
80+00
85+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
KAU 20
KAU 21
KAU 22
KAU 23
KAU 24
KAU 25
Match Line
Match Line
Match Line
Match Line
MAMALAHOA HWY.
Top of Road
40' X 6' Reinforced Concrete Box Culvert
1180
1160
1140
1120
1100
1080
1060
90+00
95+00
100+00
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAUMALUMALU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 5 of 13

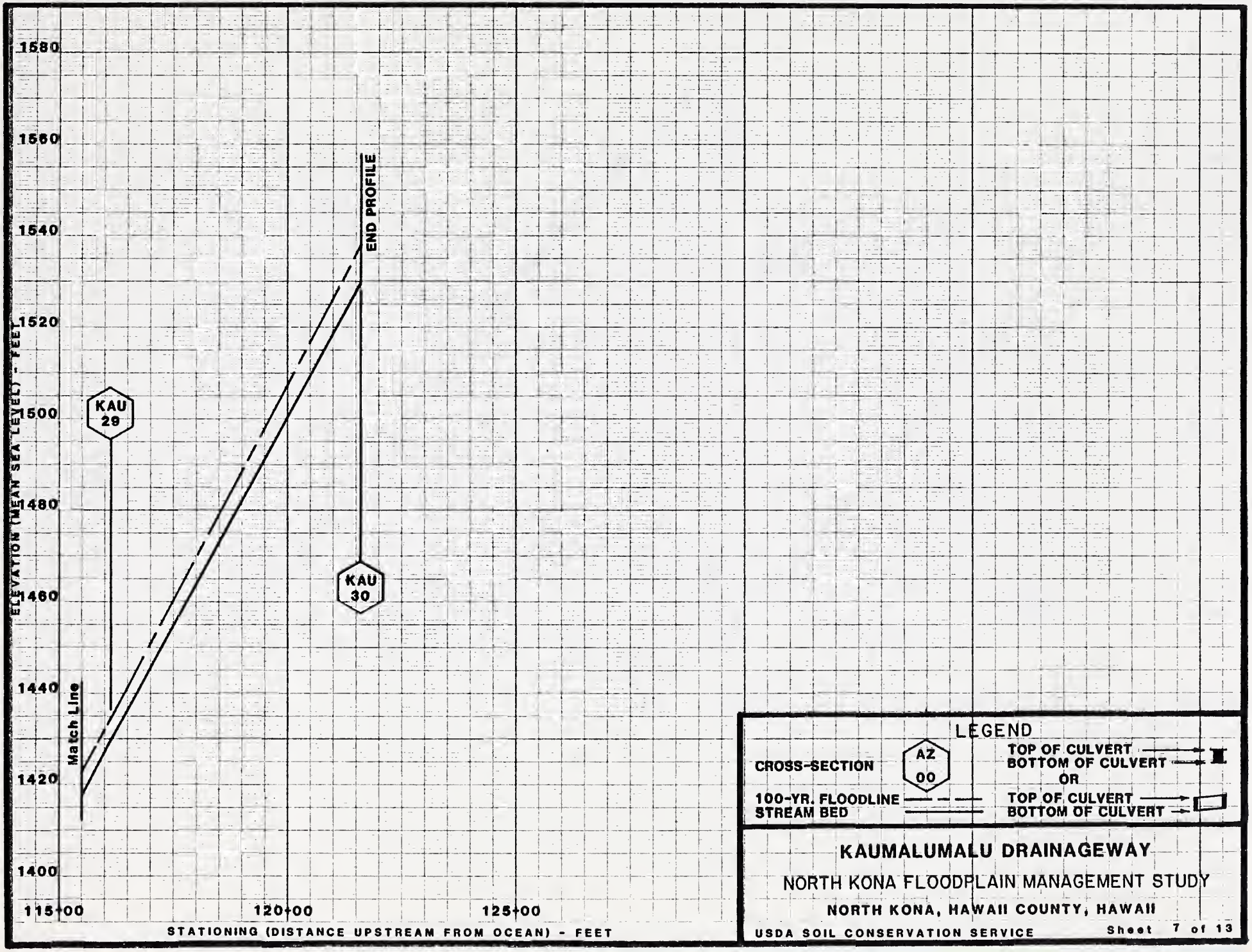


KAUMALUMALU DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

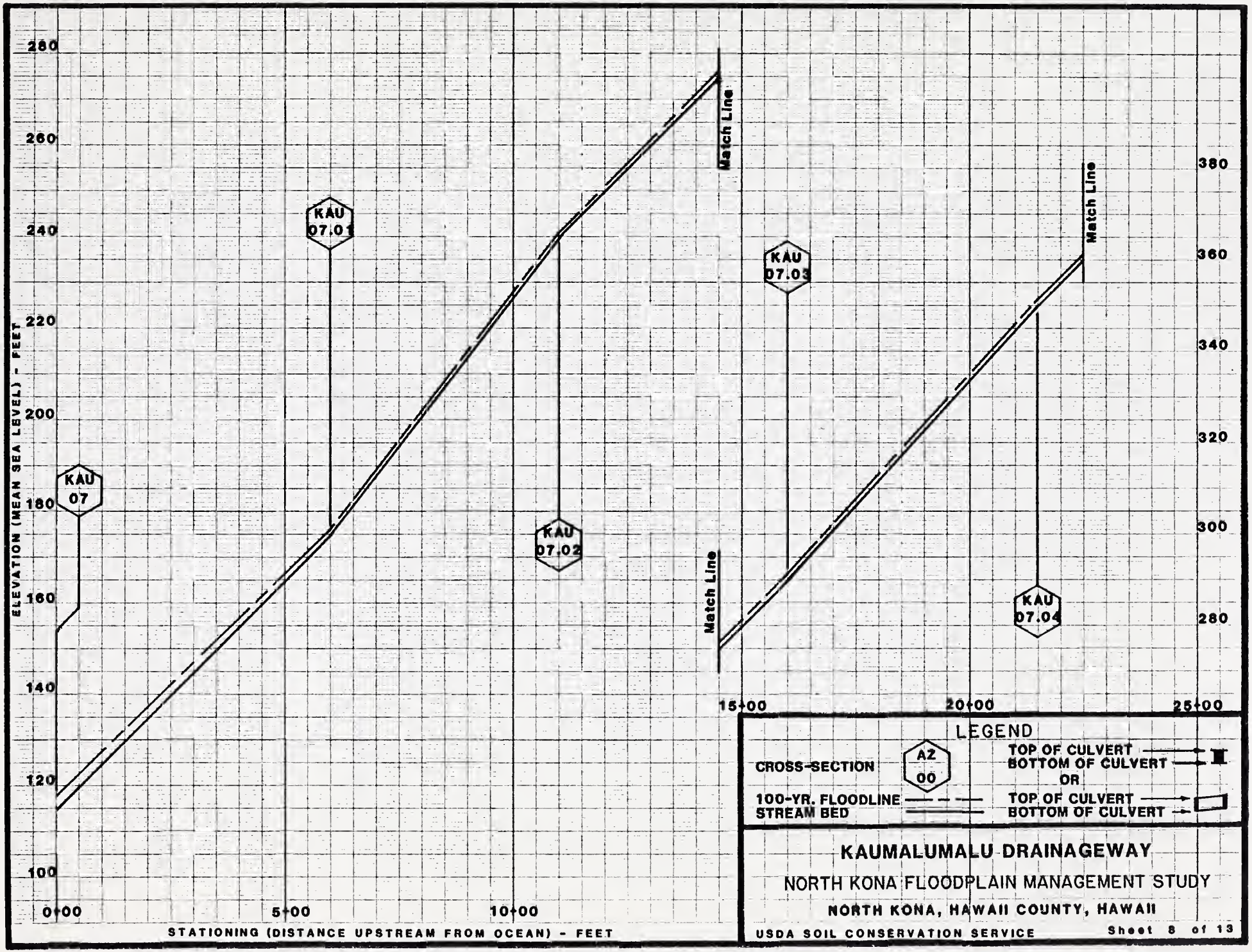


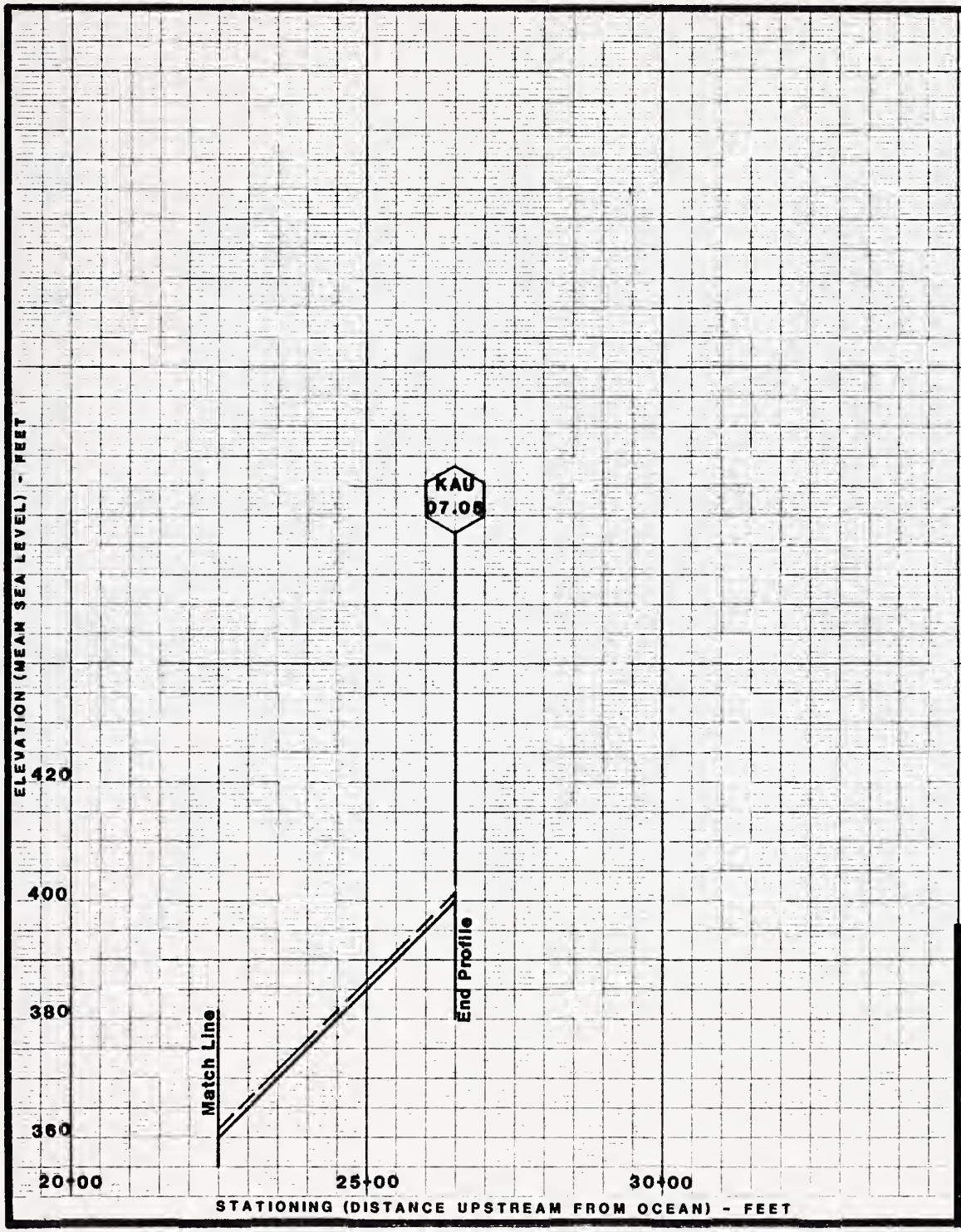
KAUMALUMALU DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


ELEVATION (MEAN SEA LEVEL) - FEET
280
260
240
220
200
180
160
140
120
100
380
360
340
320
300
280
0+00
5+00
10+00
15+00
20+00
25+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
KAU 07
KAU 07.01
KAU 07.02
KAU 07.03
KAU 07.04
Match Line
Match Line
Match Line
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAUMALUMALU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 8 of 13



LEGEND

CROSS-SECTION — AZ / 00

100-YR. FLOODLINE

STREAM BED

TOP OF CULVERT
BOTTOM OF CULVERT

OR

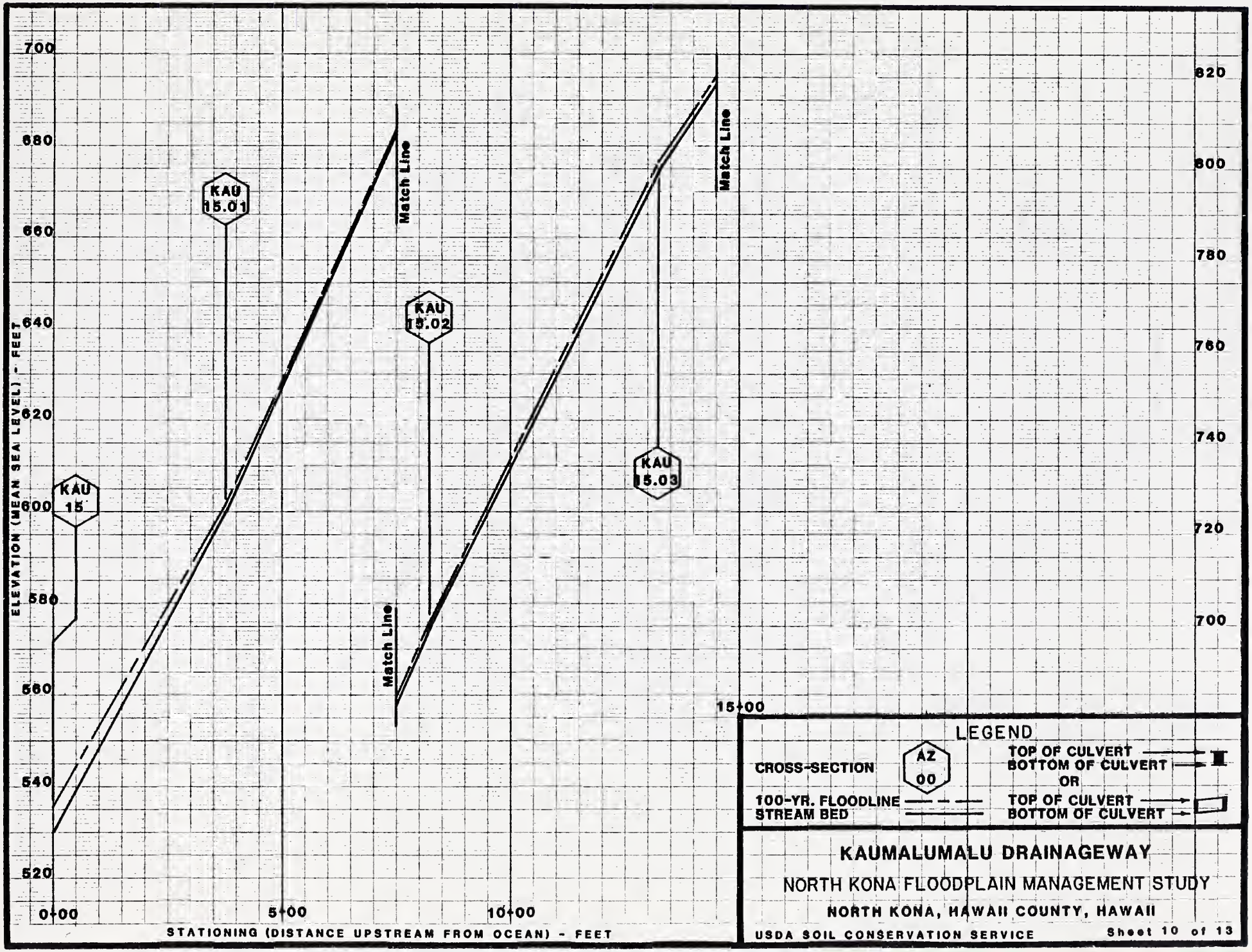
TOP OF CULVERT
BOTTOM OF CULVERT

KAUMALUMALU DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

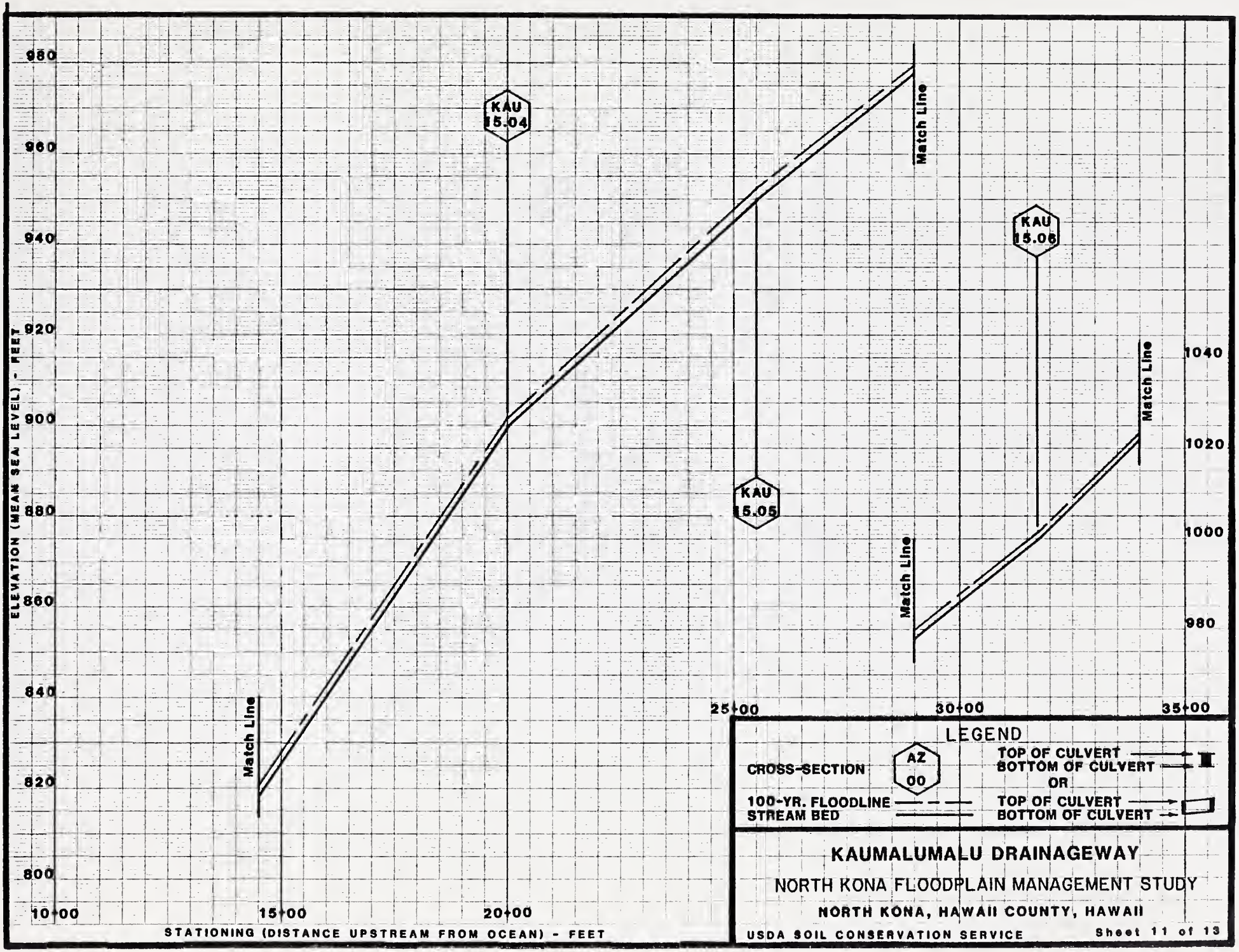


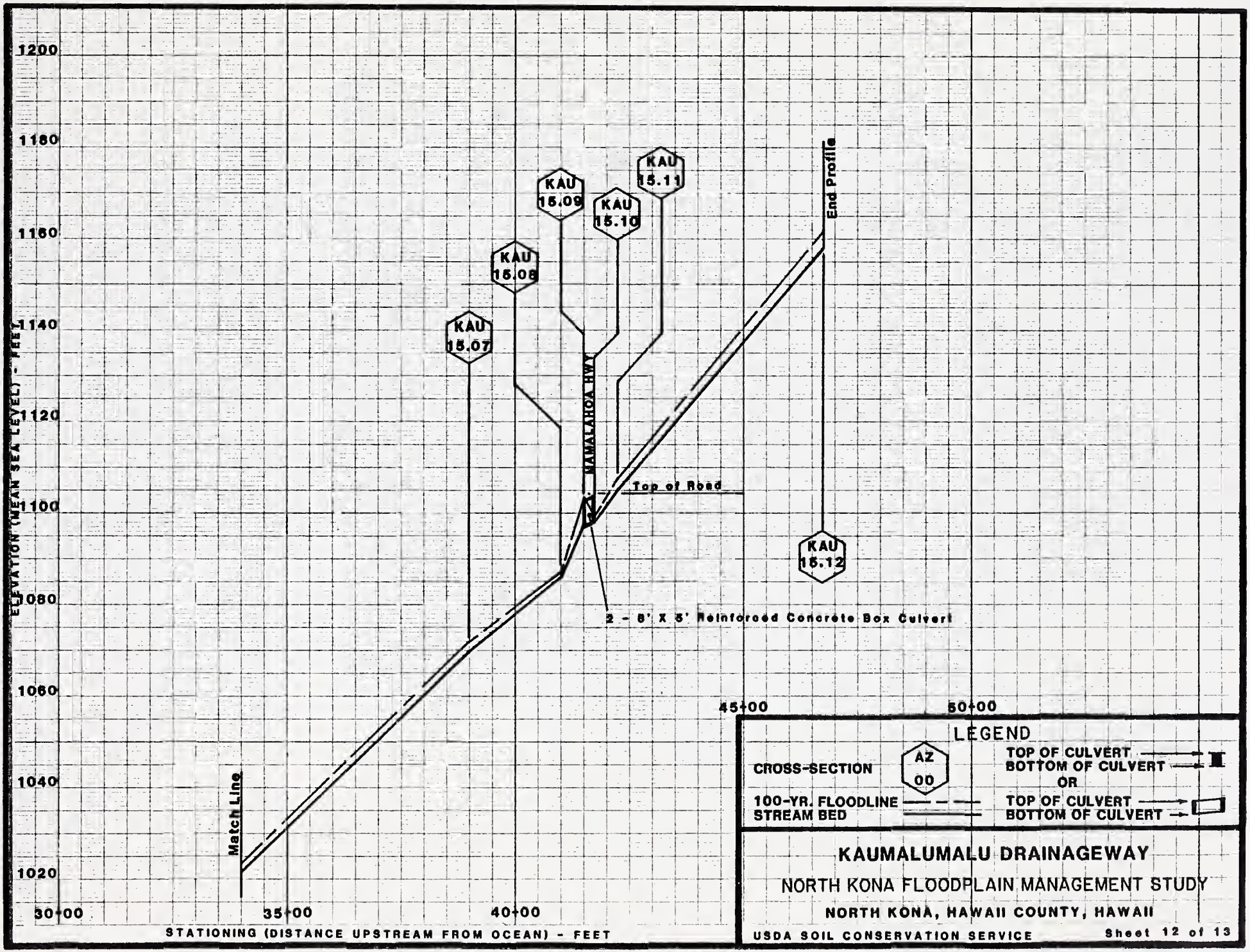
KAUMALUMALU DRAINAGEWAY

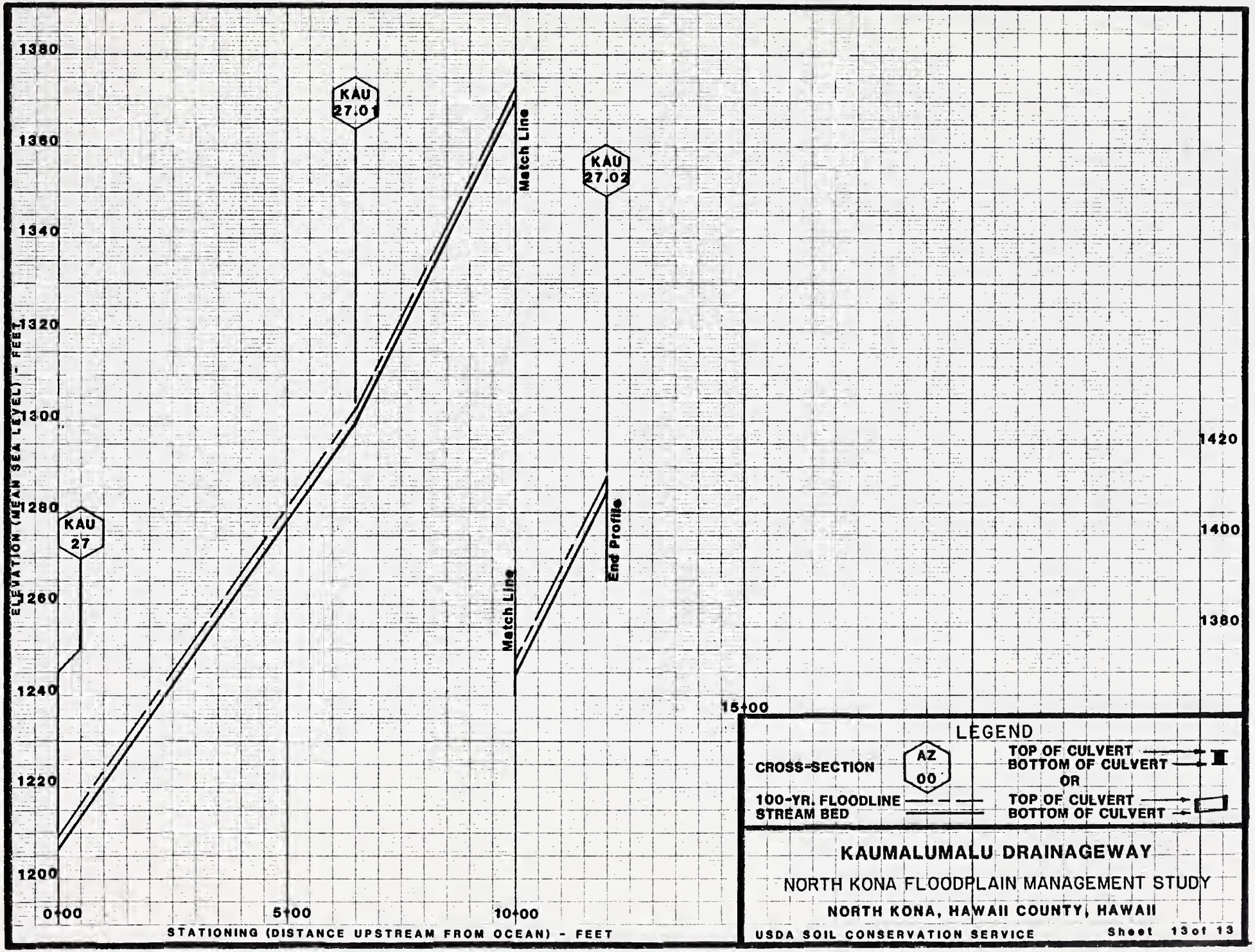
NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


980
960
940
920
900
880
860
840
820
800
ELEVATION (MEAN SEA LEVEL) - FEET
KAU 15.04
KAU 15.05
KAU 15.06
Match Line
Match Line
Match Line
Match Line
1040
1020
1000
980
10+00
15+00
20+00
25+00
30+00
35+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAUMALUMALU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 11 of 13


1200
1180
1160
1140
1120
1100
1080
1060
1040
1020
ELEVATION (MEAN SEA LEVEL) - FEET
KAU 15.07
KAU 15.08
KAU 15.09
KAU 15.10
KAU 15.11
KAU 15.12
End Profile
KAMALAHOA HWY
Top of Road
2 - 8' X 5' Reinforced Concrete Box Culvert
Match Line
30+00
35+00
40+00
45+00
50+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAUMALUMALU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 12 of 13

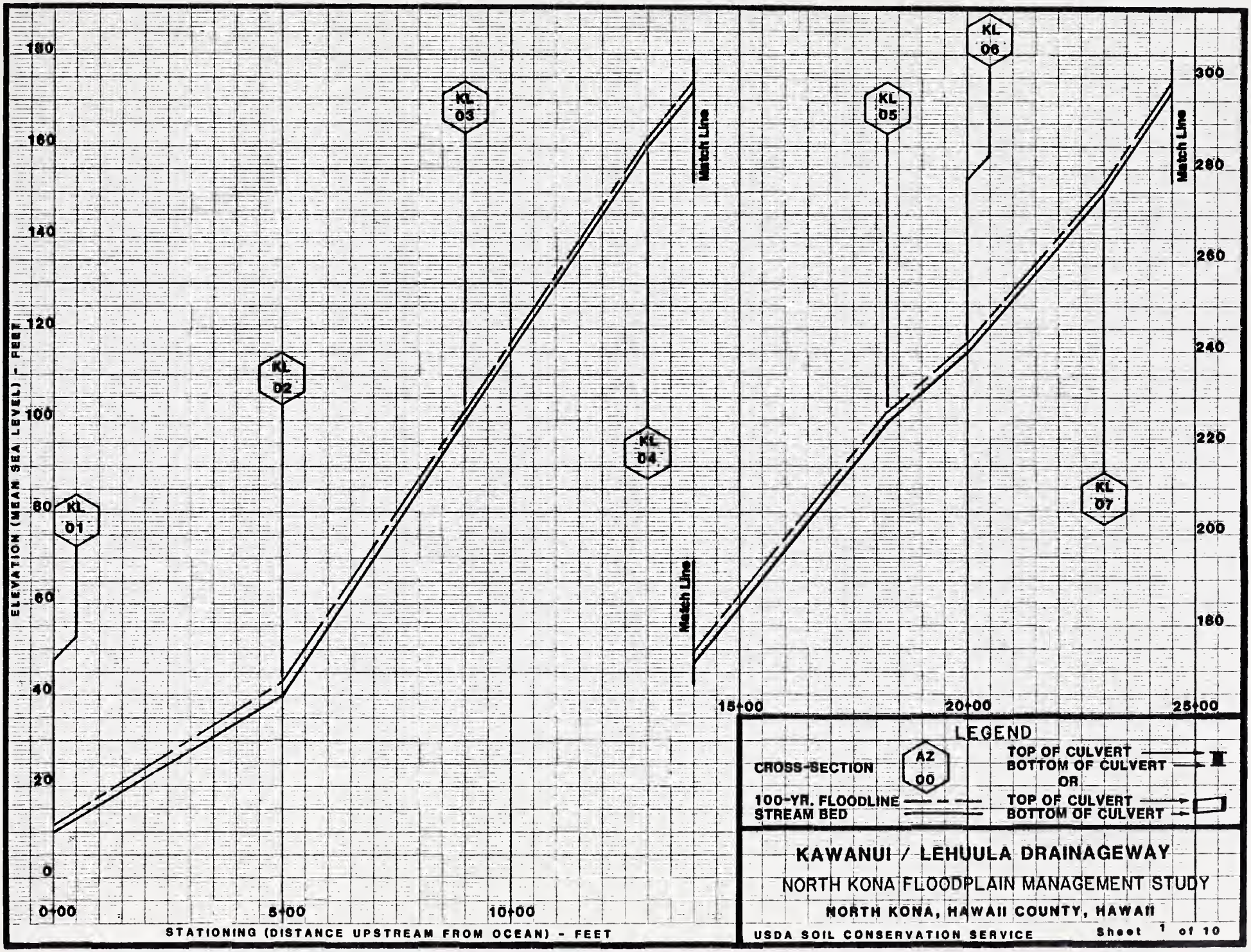


KAUMALUMALU DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

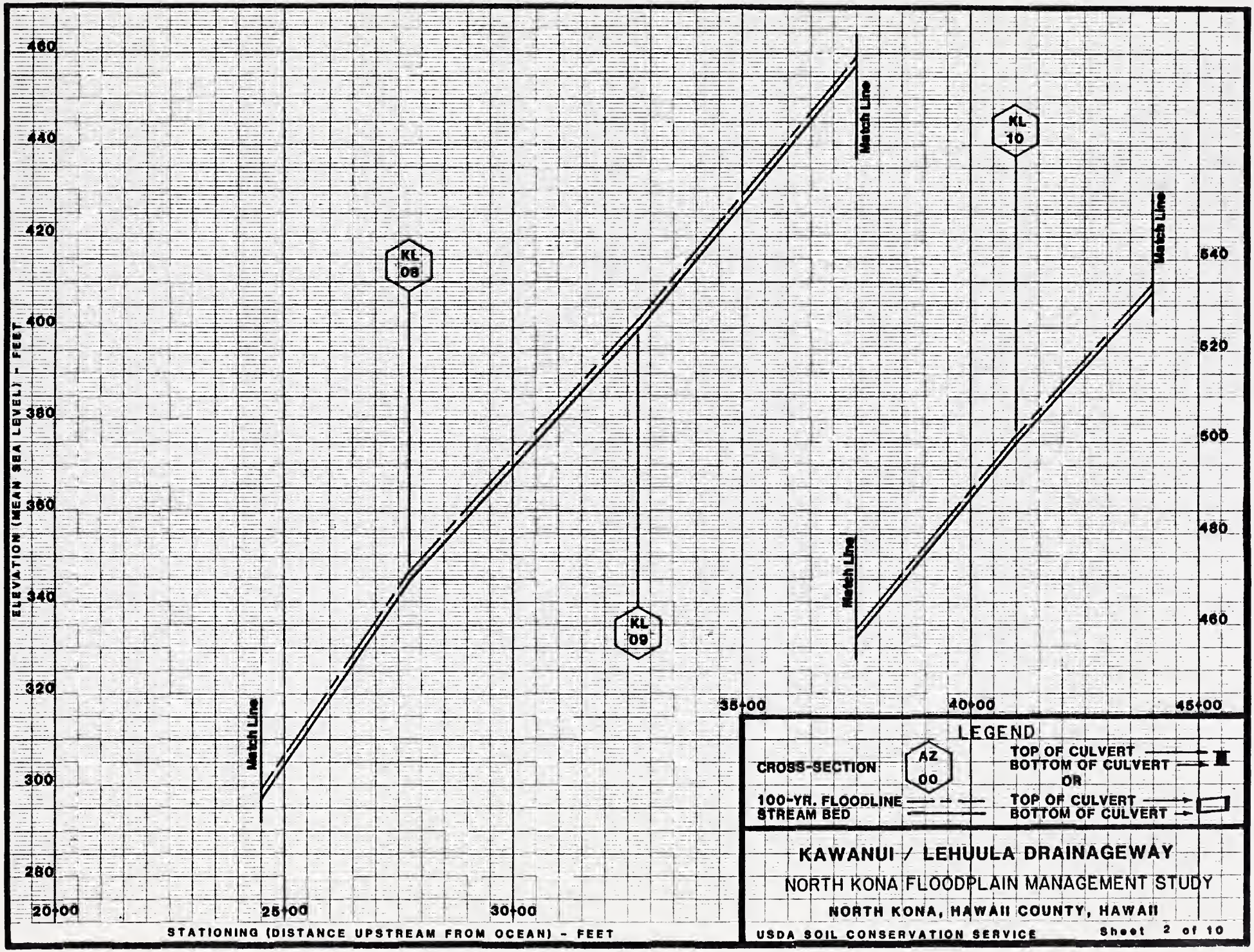


KAWANUI / LEHUULA DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

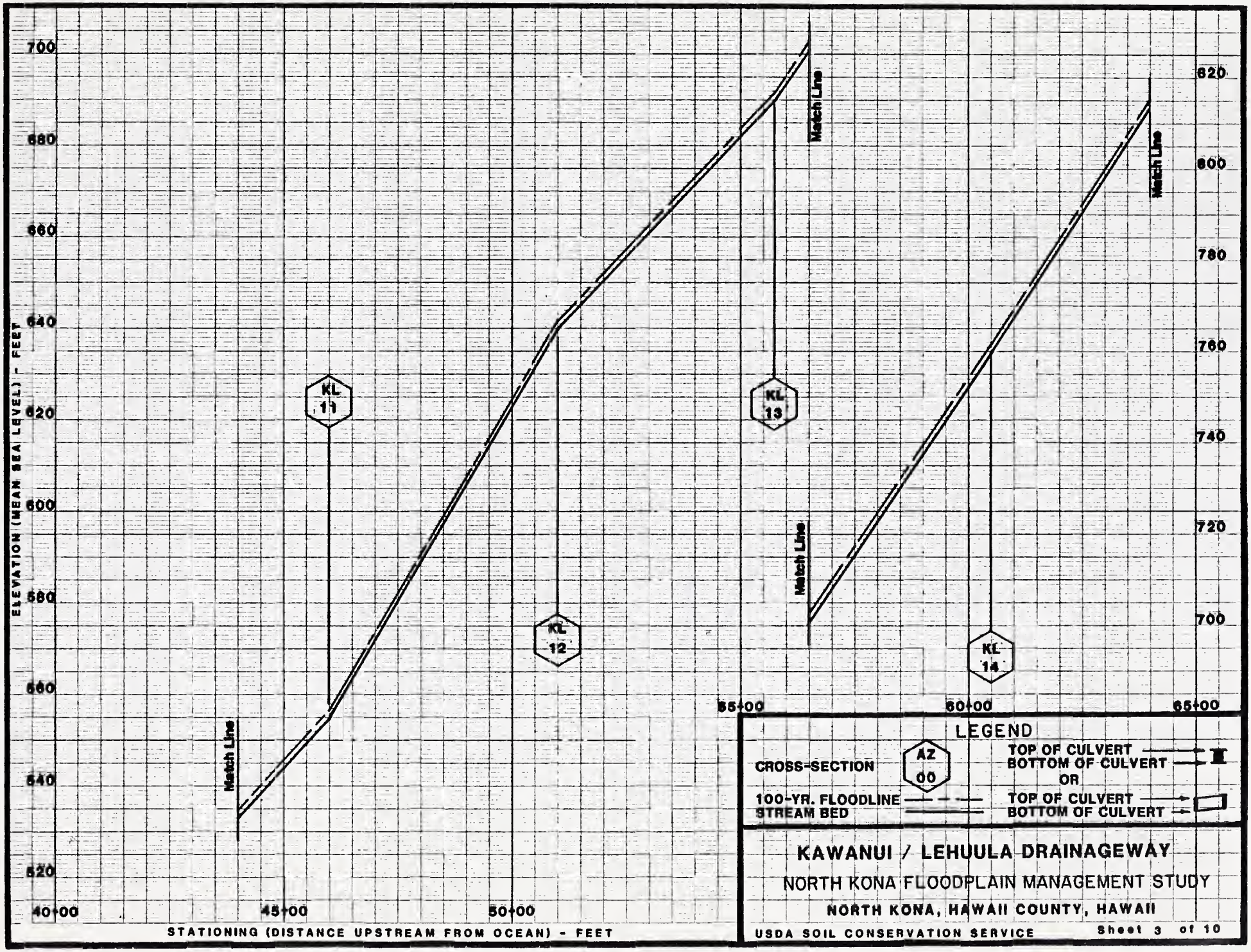


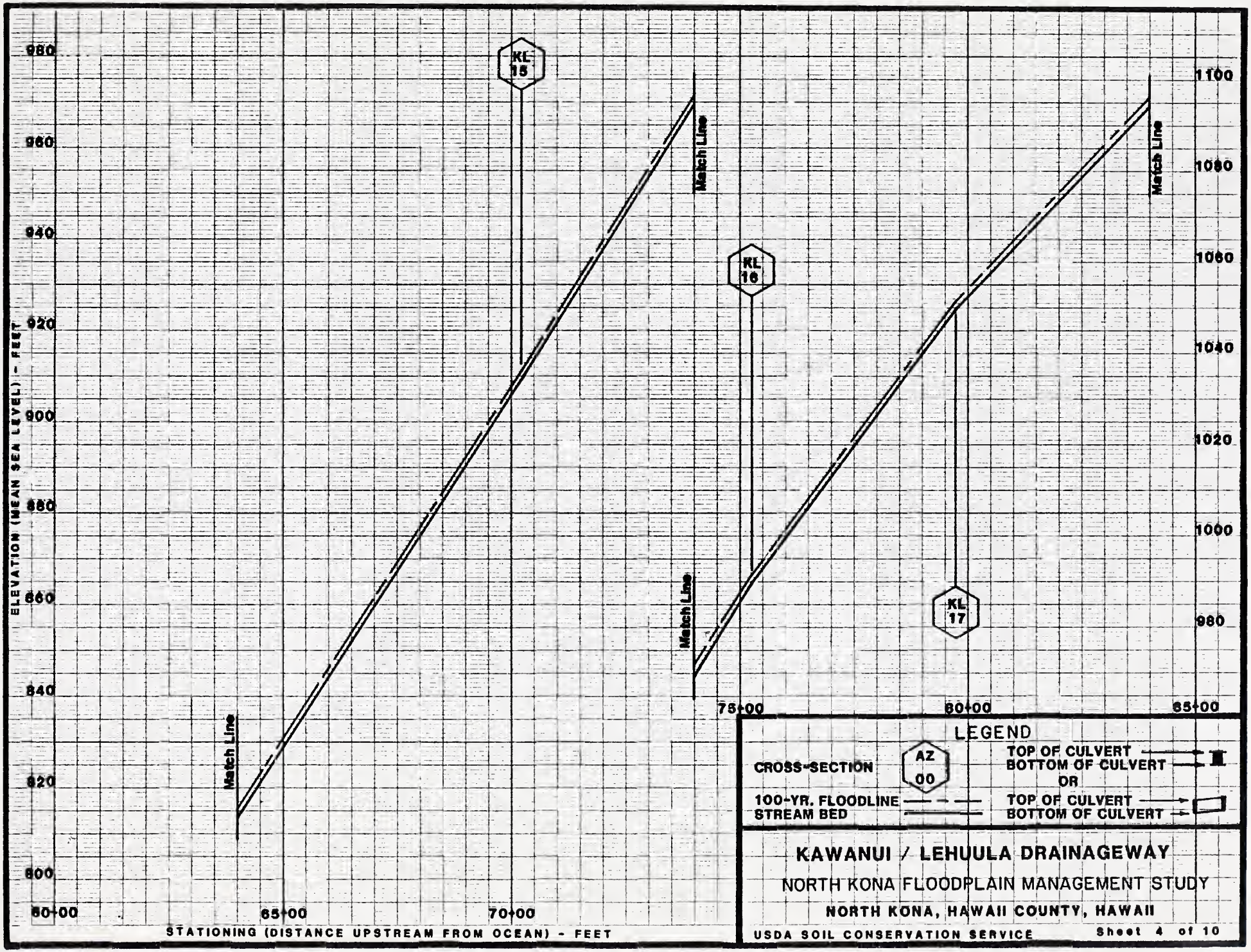
KAWANUI / LEHUULA DRAINAGEWAY

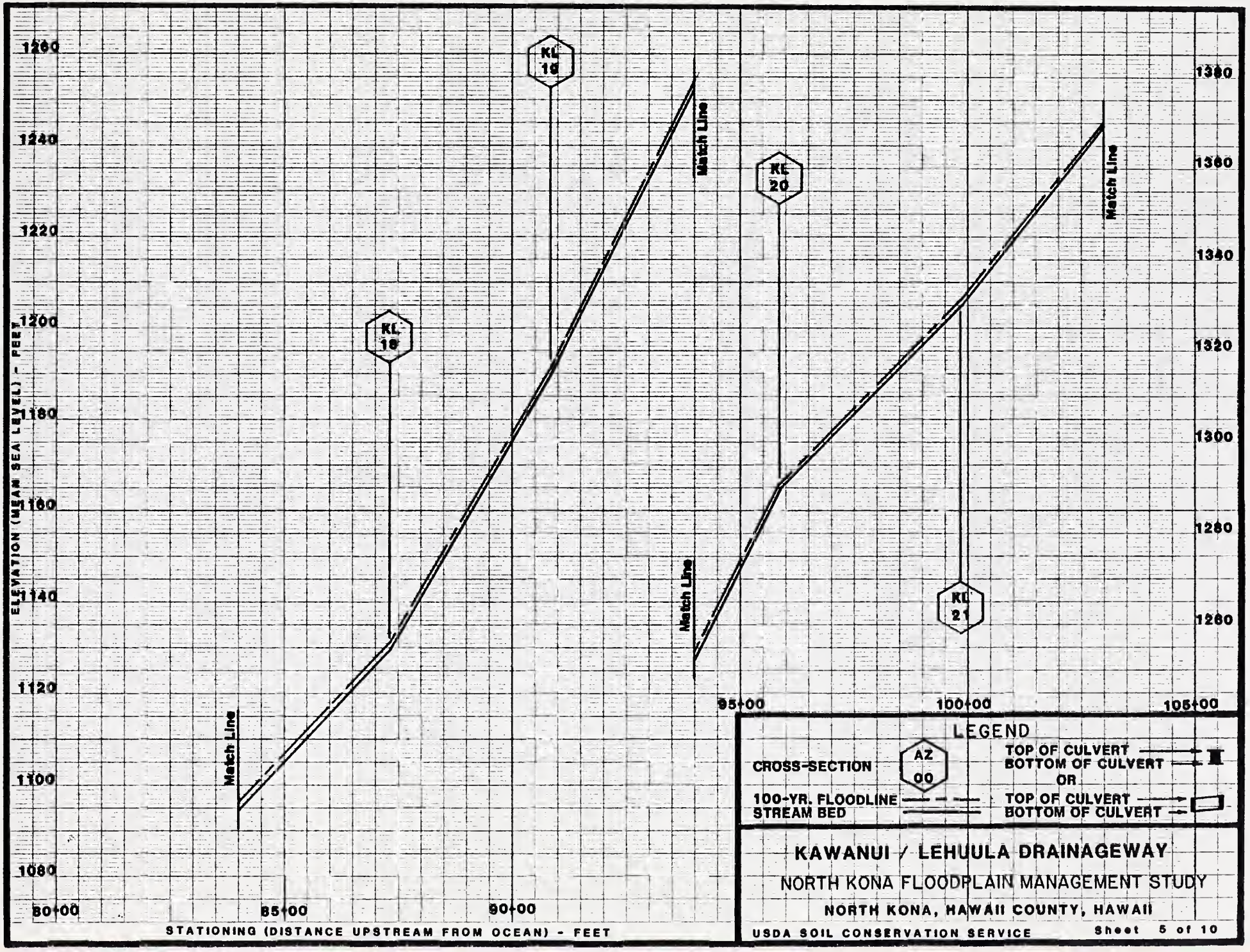
NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


700
680
660
640
620
600
580
560
540
520
ELEVATION (MEAN SEA LEVEL) - FEET
40+00
45+00
50+00
55+00
60+00
65+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
Match Line
Match Line
Match Line
Match Line
KL 11
KL 12
KL 13
KL 14
620
600
780
760
740
720
700
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAWANUI / LEHUULA DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 3 of 10


ELEVATION (MEAN SEA LEVEL) - FEET
980
960
940
920
900
880
860
840
820
800
1100
1080
1060
1040
1020
1000
980
KL 15
KL 16
KL 17
Match Line
Match Line
Match Line
Match Line
60+00
65+00
70+00
75+00
80+00
85+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAWANUI / LEHUULA DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 4 of 10



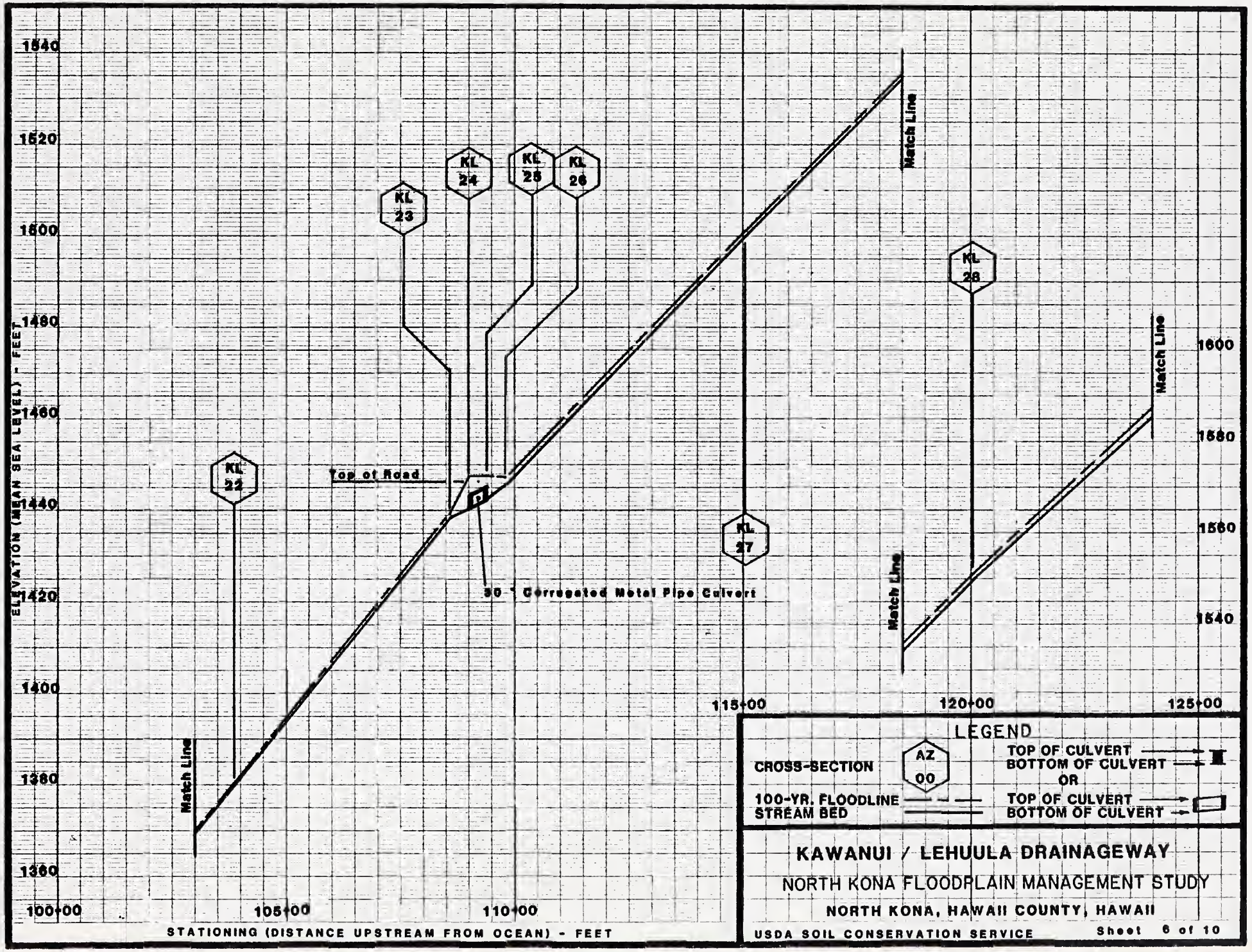
KAWANUI / LEHUULA DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

Sheet 5 of 10



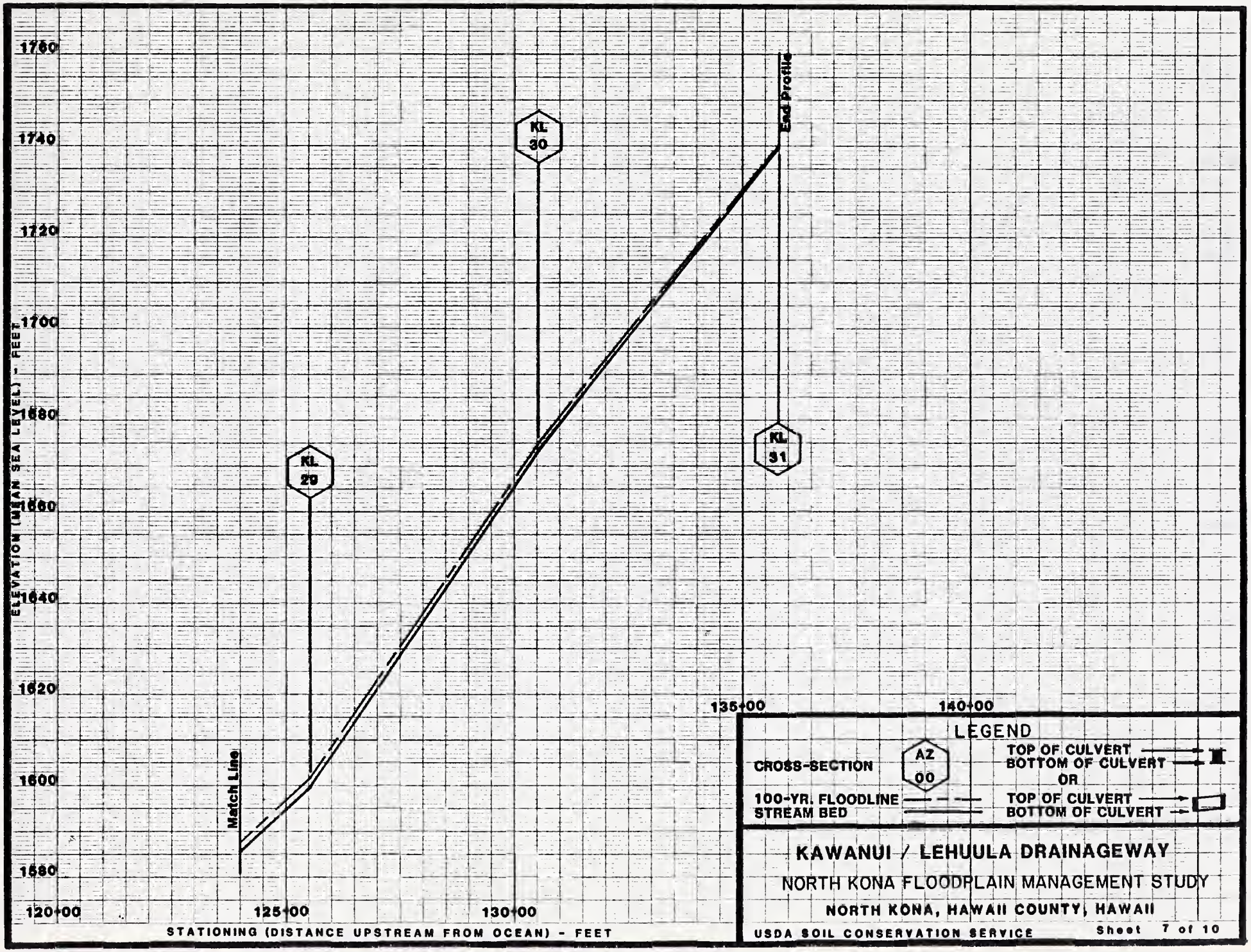
KAWANUI / LEHUULA DRAINAGEWAY

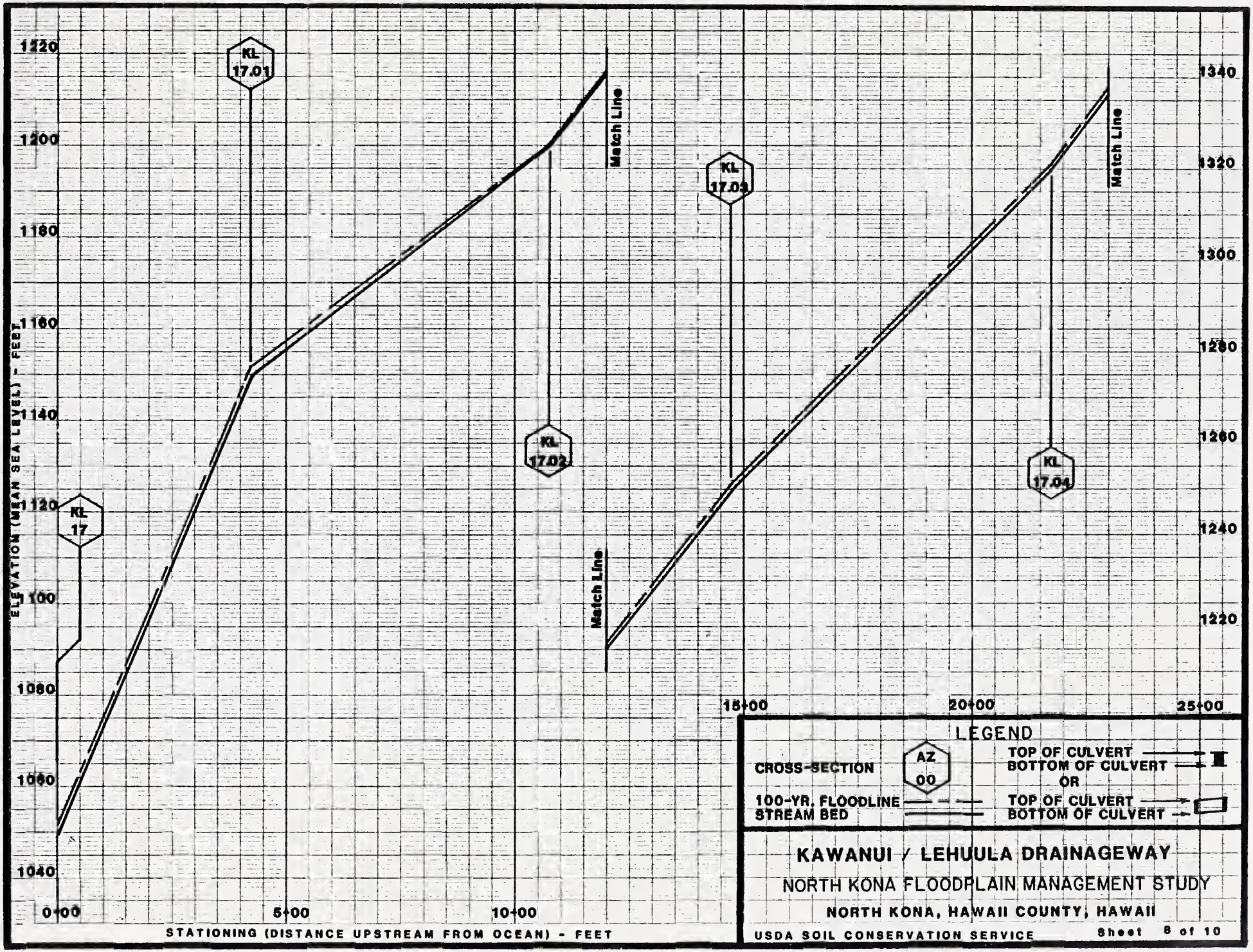
NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE

Sheet 6 of 10


1760
1740
1720
1700
1680
1660
1640
1620
1600
1580
ELEVATION (MEAN SEA LEVEL) - FEET
KL 30
KL 31
KL 29
End Profile
Match Line
120+00
125+00
130+00
135+00
140+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAWANUI / LEHUULA DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 7 of 10

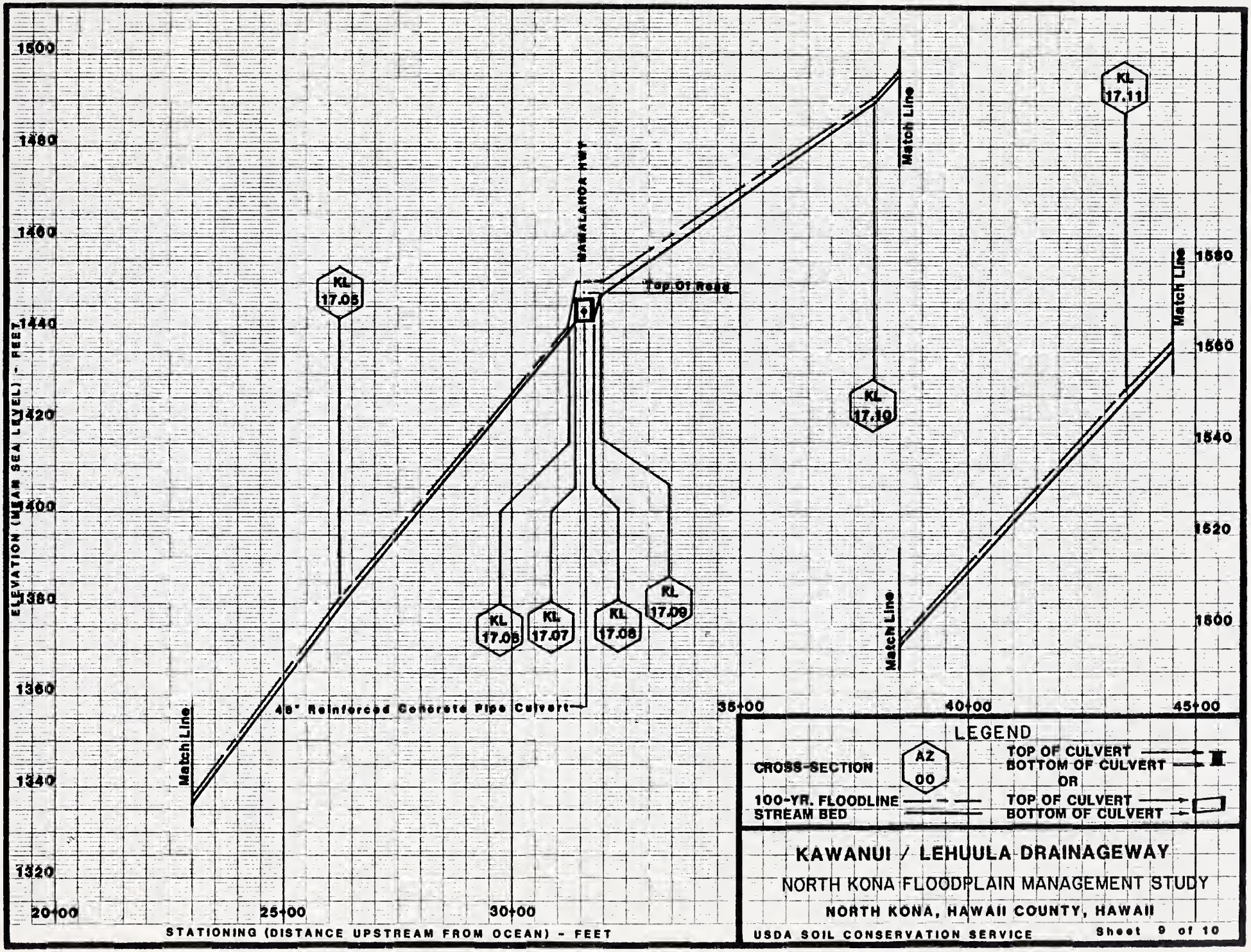


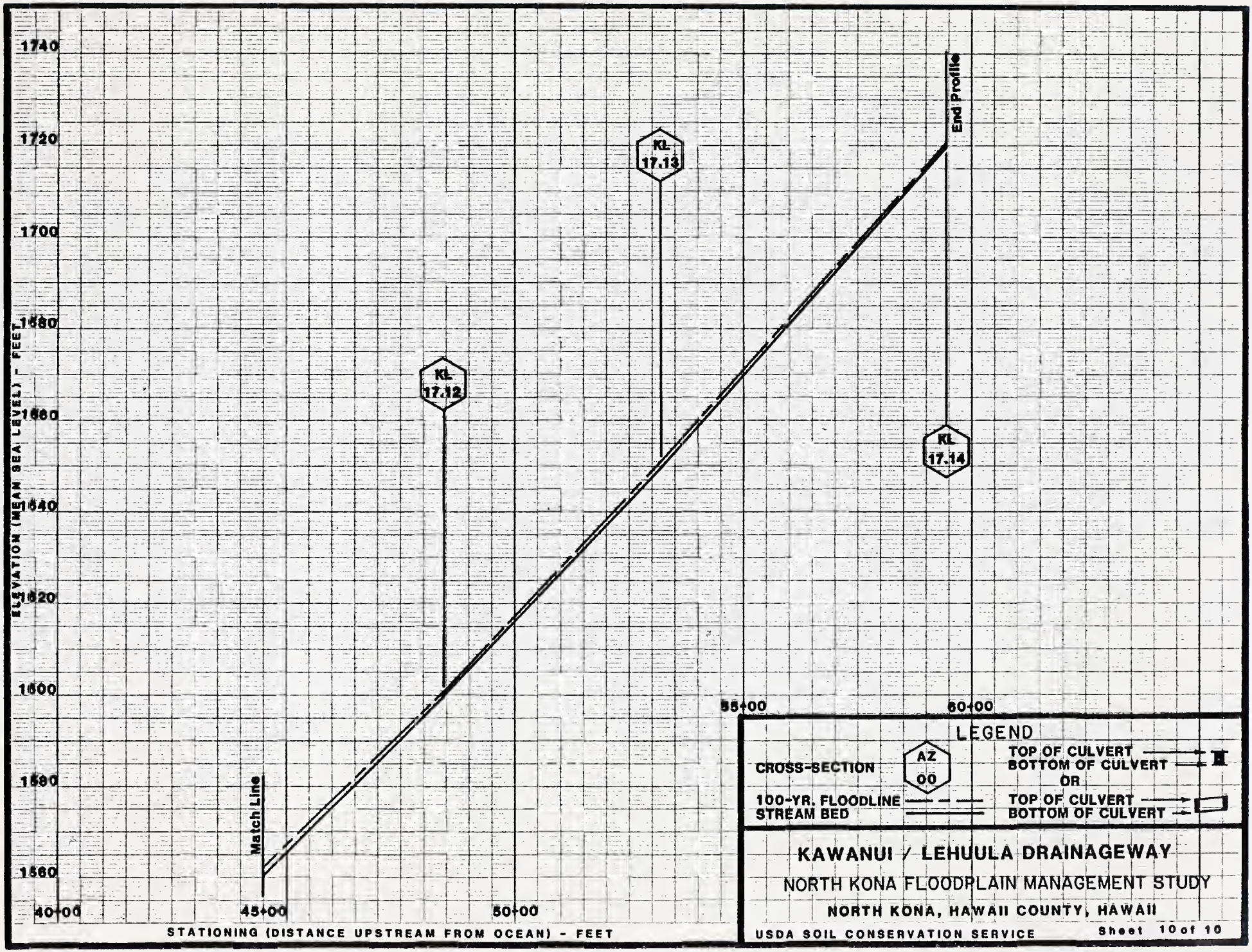
KAWANUI / LEHUULA DRAINAGEWAY

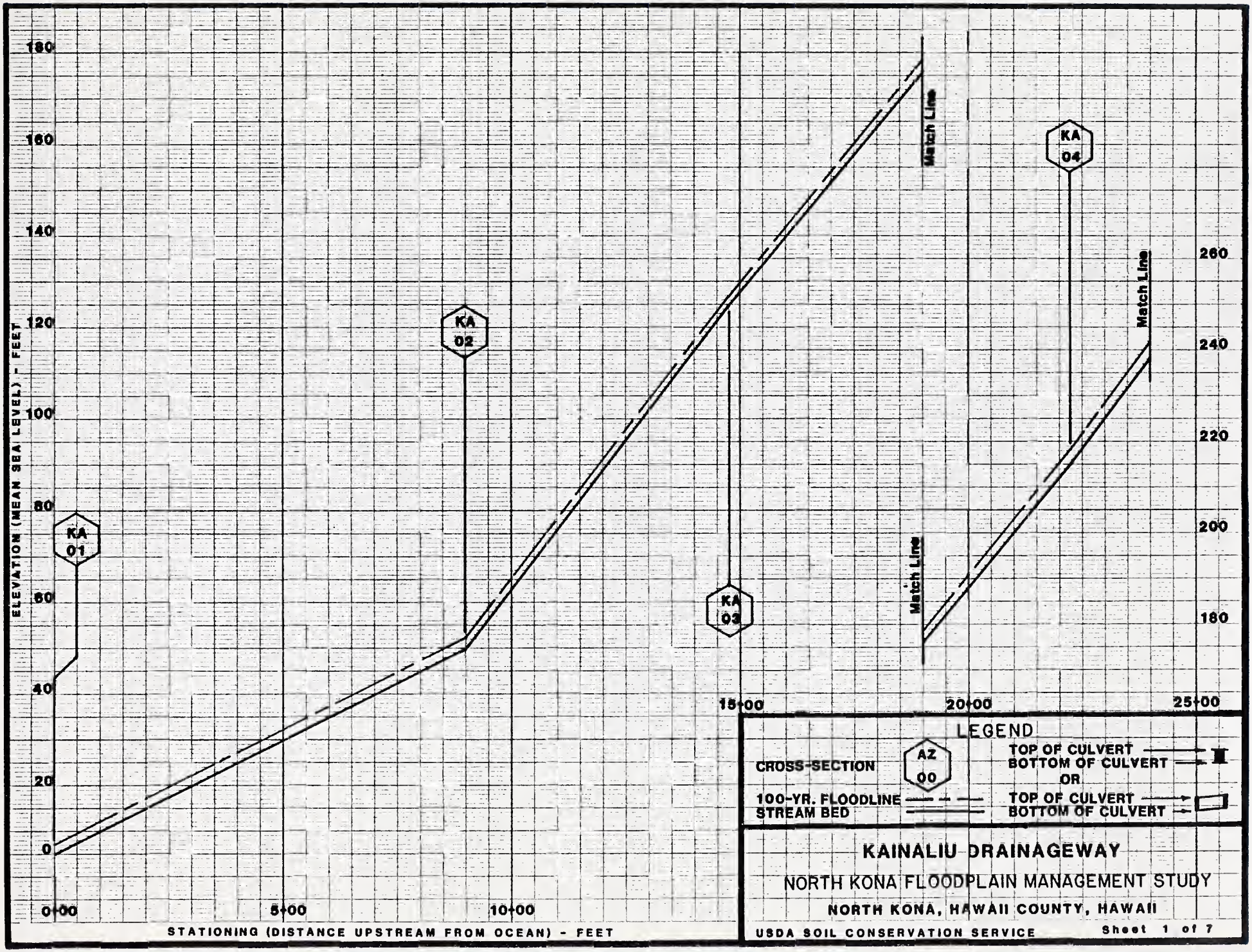
NORTH KONA FLOODPLAIN MANAGEMENT STUDY

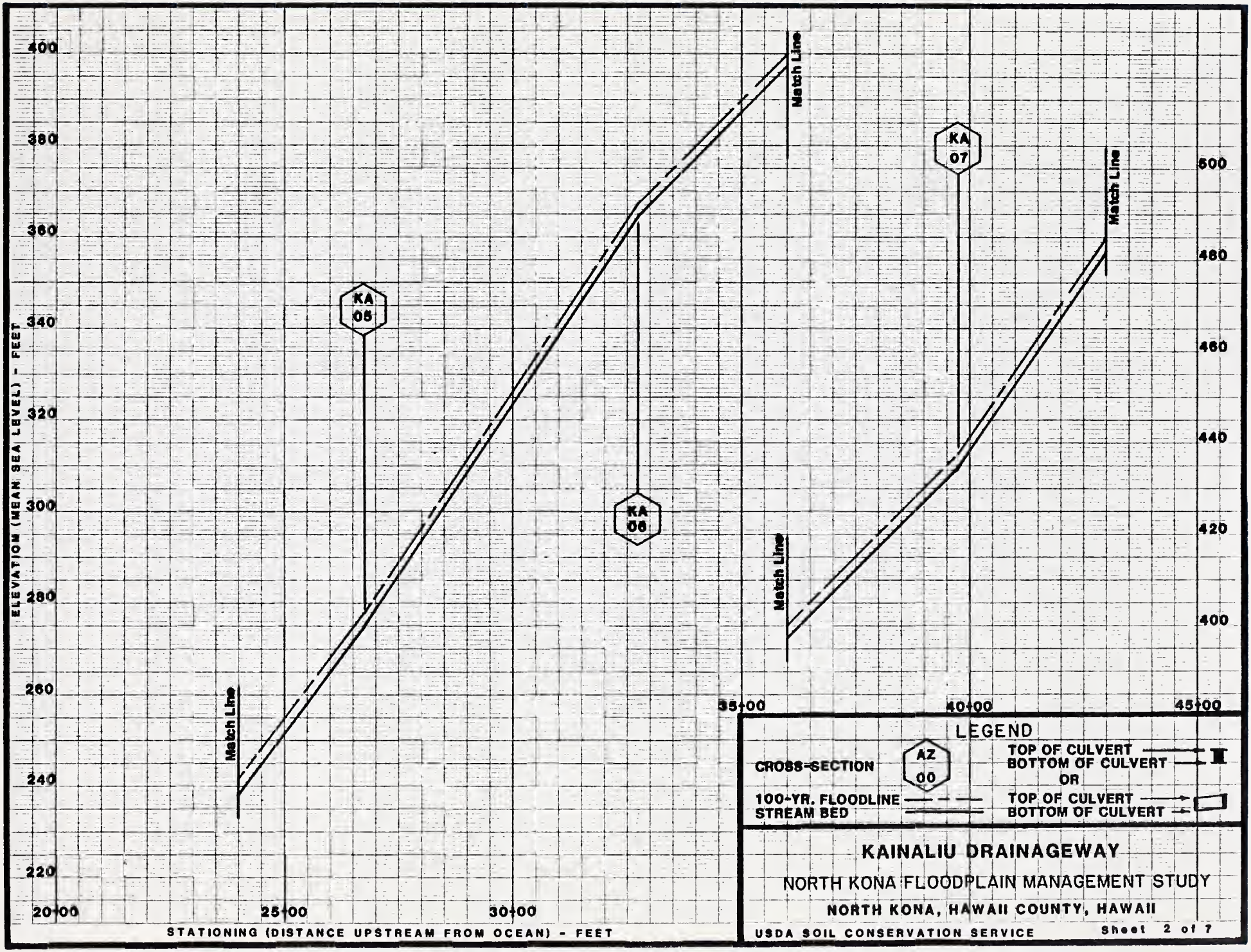
NORTH KONA, HAWAII COUNTY, HAWAII

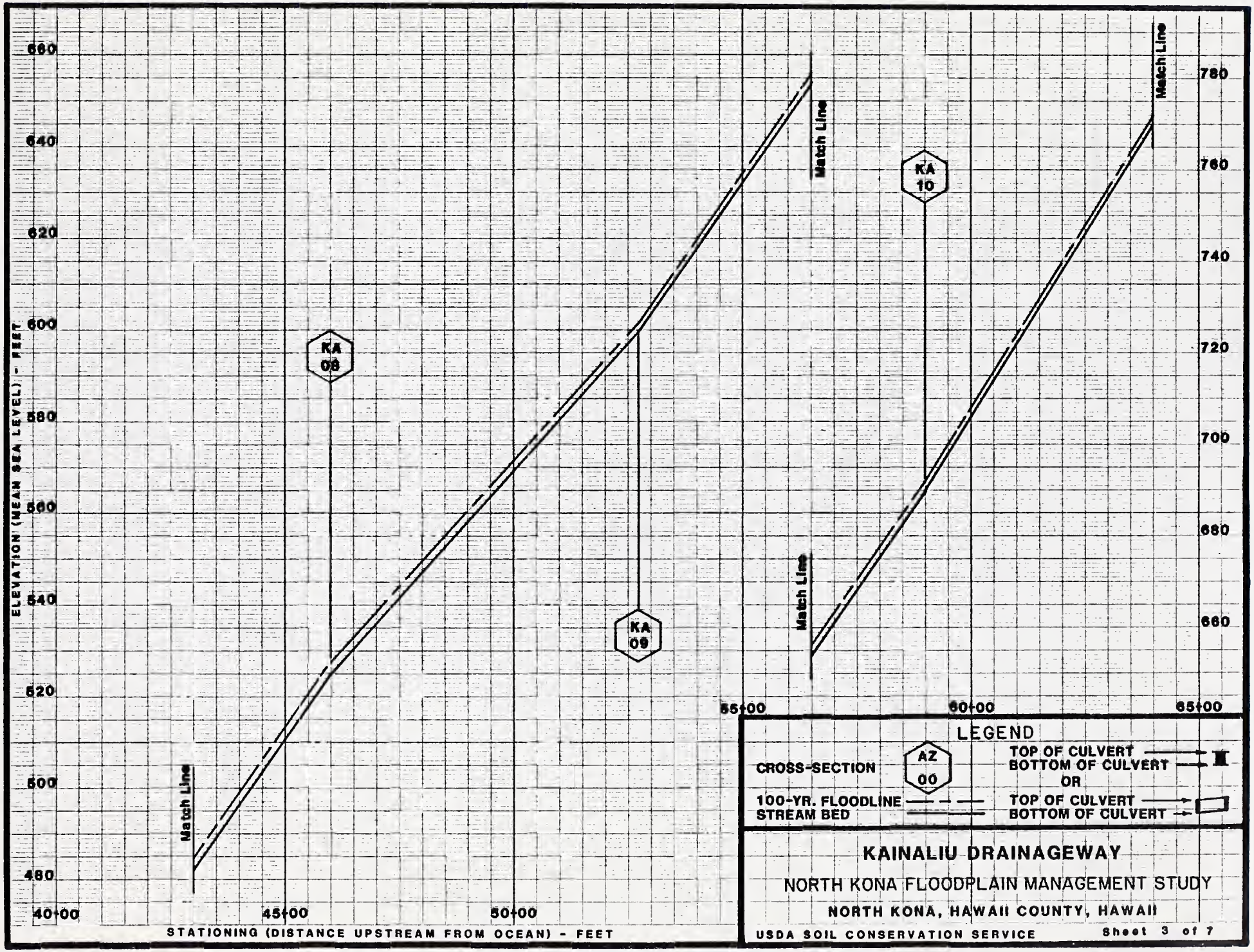
USDA SOIL CONSERVATION SERVICE

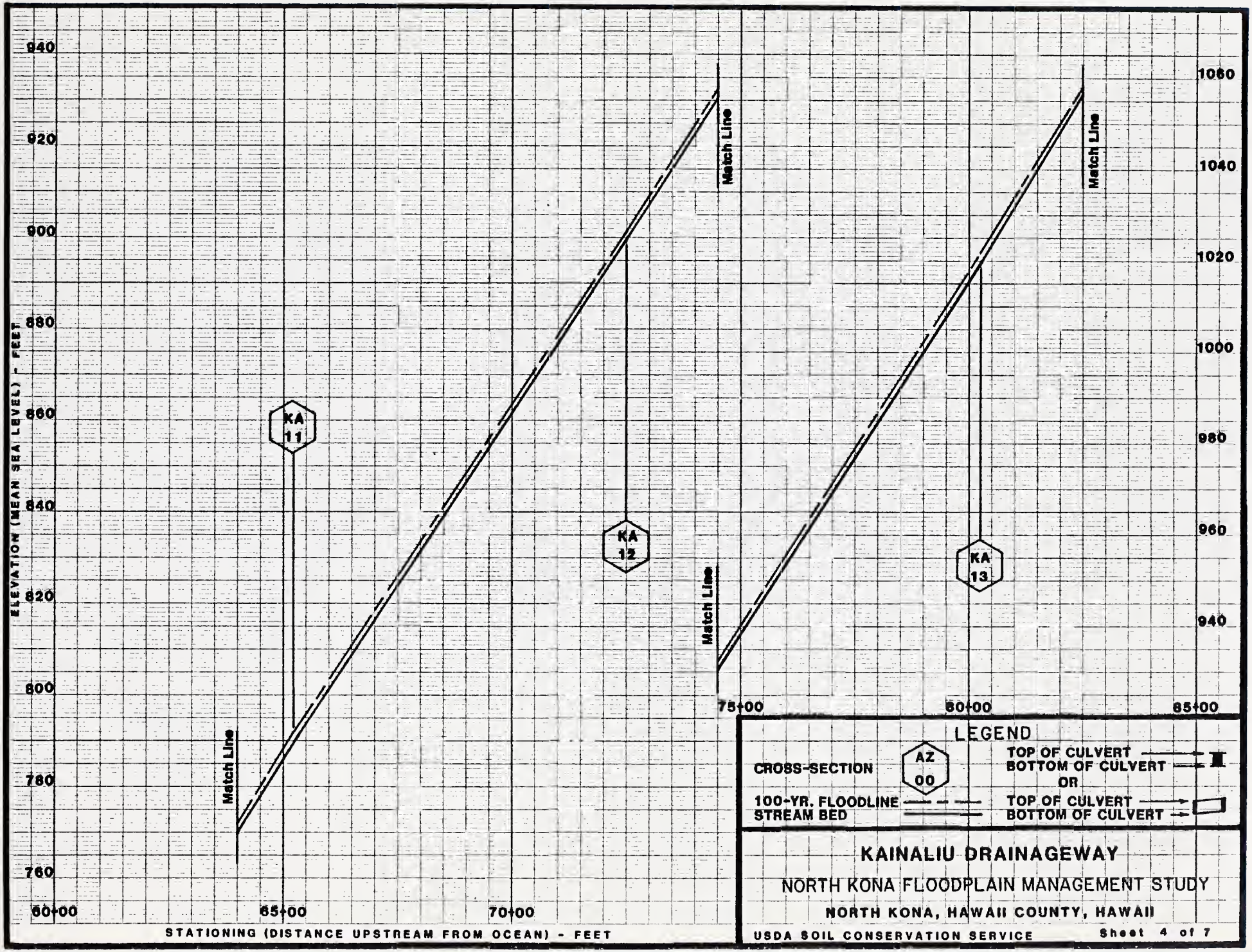

ELEVATION (MEAN SEA LEVEL) - FEET
1500
1480
1460
1440
1420
1400
1380
1360
1340
1320
20+00
25+00
30+00
35+00
40+00
45+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
Match Line
48" Reinforced Concrete Pipe Culvert
HAWAIIAN HWY
Top Of Road
KL 17.05
KL 17.06
KL 17.07
KL 17.08
KL 17.09
KL 17.10
KL 17.11
Match Line
Match Line
Match Line
1560
1540
1520
1500
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAWANUI / LEHUULA DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 9 of 10

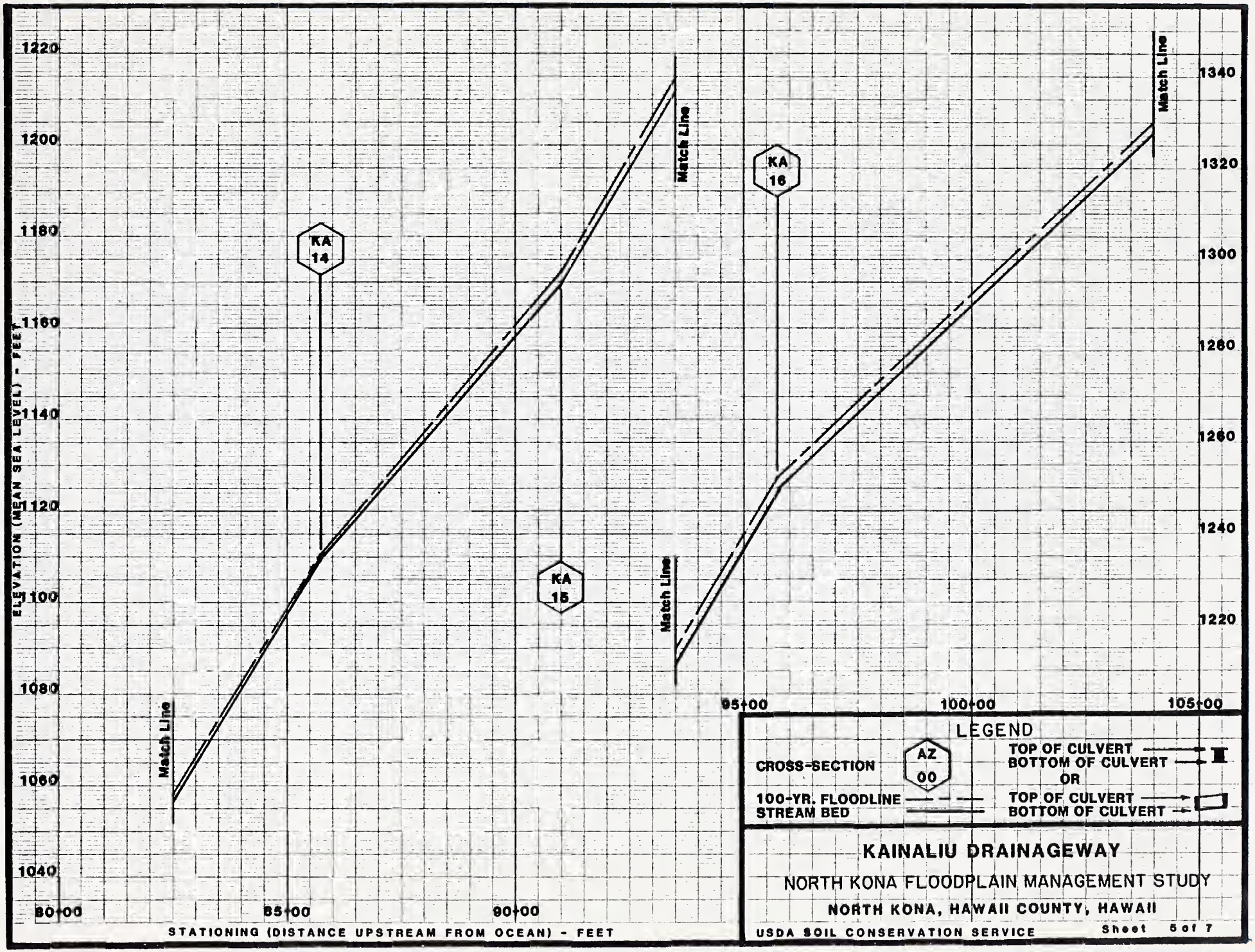

1740
1720
1700
1680
1660
1640
1620
1600
1580
1560
ELEVATION (MEAN SEA LEVEL) - FEET
40+00
45+00
50+00
55+00
60+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
Match Line
End Profile
KL 17.12
KL 17.13
KL 17.14
LEGEND
CROSS-SECTION
AZ
00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAWANUI / LEHUULA DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 10 of 10


ELEVATION (MEAN SEA LEVEL) - FEET
180
160
140
120
100
80
60
40
20
0
260
240
220
200
180
KA 01
KA 02
KA 03
KA 04
Match Line
Match Line
Match Line
0+00
5+00
10+00
15+00
20+00
25+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAINALIU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 1 of 7


ELEVATION (MEAN SEA LEVEL) - FEET
400
380
360
340
320
300
280
260
240
220
20+00
25+00
30+00
35+00
40+00
45+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
500
480
460
440
420
400
Match Line
Match Line
Match Line
Match Line
KA 05
KA 06
KA 07
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAINALIU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 2 of 7


ELEVATION (MEAN SEA LEVEL) - FEET
660
640
620
600
580
560
540
520
500
480
40+00
45+00
50+00
55+00
60+00
65+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
780
760
740
720
700
680
660
Match Line
Match Line
Match Line
Match Line
KA 08
KA 09
KA 10
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAINALIU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 3 of 7


940
920
900
880
860
840
820
800
780
760
ELEVATION (MEAN SEA LEVEL) - FEET
1060
1040
1020
1000
980
960
940
Match Line
Match Line
Match Line
KA 11
KA 12
KA 13
60+00
65+00
70+00
75+00
80+00
85+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAINALIU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 4 of 7

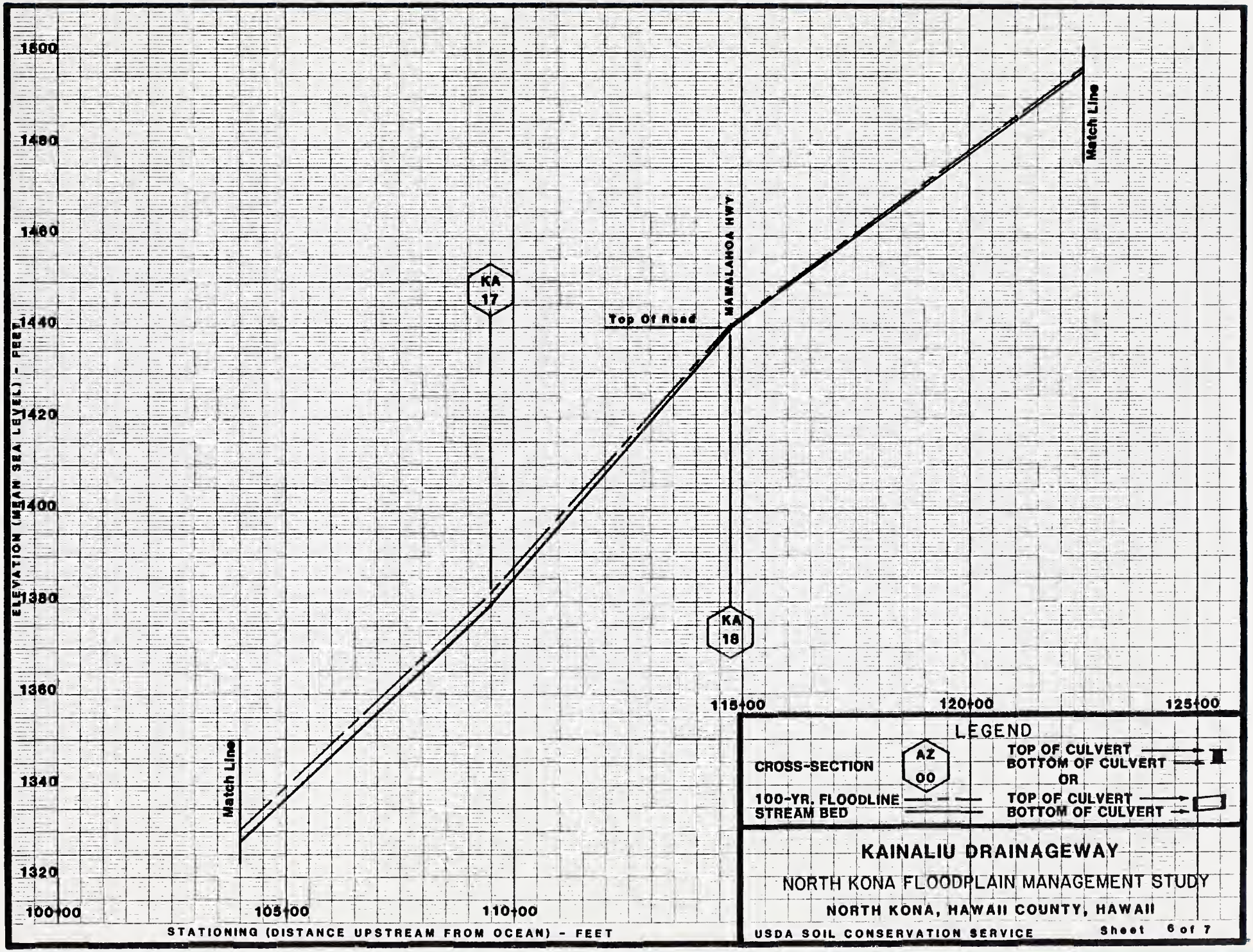


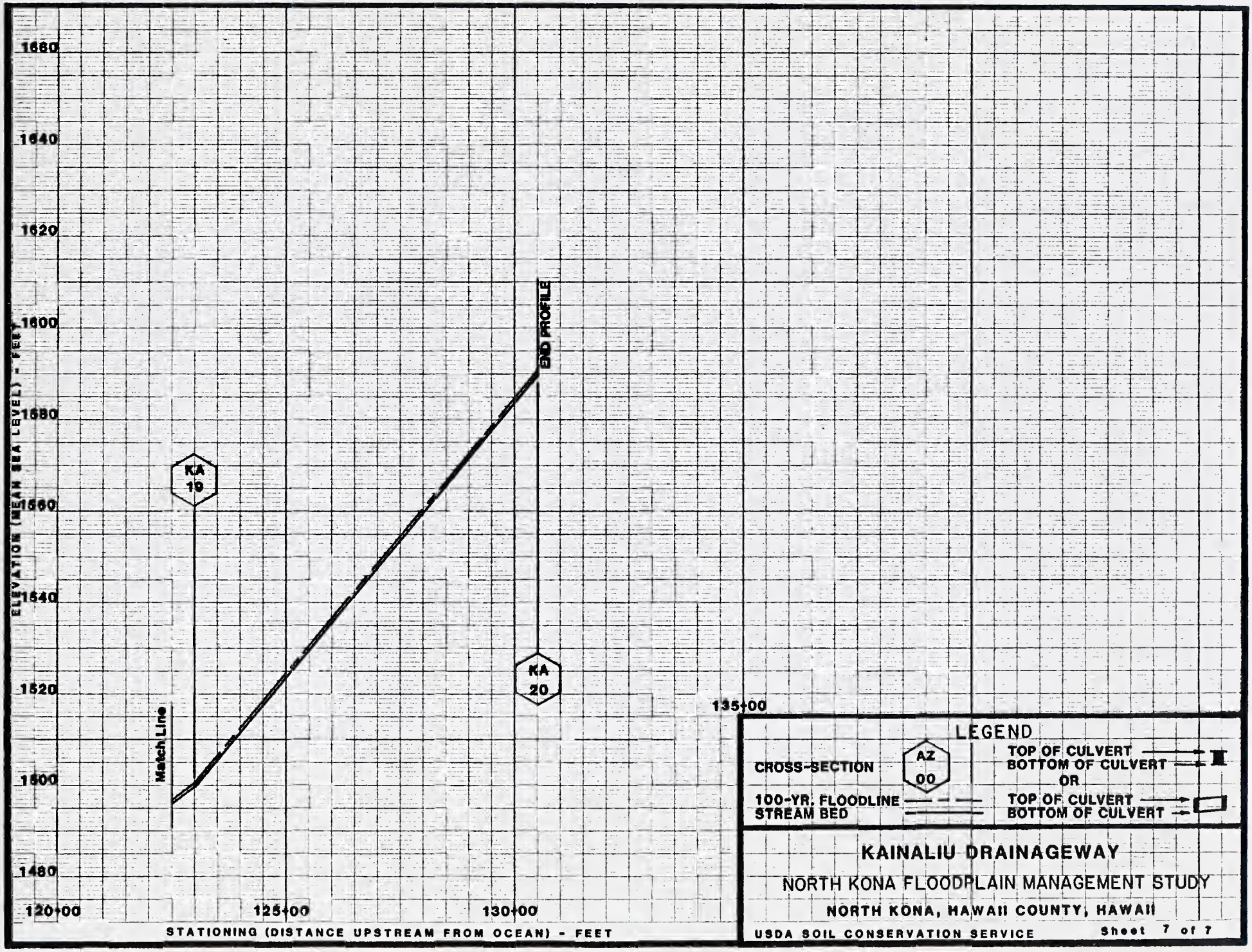
KAINALIU DRAINAGEWAY

NORTH KONA FLOODPLAIN MANAGEMENT STUDY

NORTH KONA, HAWAII COUNTY, HAWAII

USDA SOIL CONSERVATION SERVICE


1500
1480
1460
1440
1420
1400
1380
1360
1340
1320
ELEVATION (MEAN SEA LEVEL) - FEET
100+00
105+00
110+00
115+00
120+00
125+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
Match Line
KA 17
Top Of Road
MAMALAHOA HWY
KA 18
Match Line
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAINALIU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 6 of 7


1660
1640
1620
1600
1580
1560
1540
1520
1500
1480
ELEVATION (MEAN SEA LEVEL) - FEET
END PROFILE
KA 19
KA 20
Match Line
120+00
125+00
130+00
135+00
STATIONING (DISTANCE UPSTREAM FROM OCEAN) - FEET
LEGEND
CROSS-SECTION
AZ 00
100-YR. FLOODLINE
STREAM BED
TOP OF CULVERT
BOTTOM OF CULVERT
OR
TOP OF CULVERT
BOTTOM OF CULVERT
KAINALIU DRAINAGEWAY
NORTH KONA FLOODPLAIN MANAGEMENT STUDY
NORTH KONA, HAWAII COUNTY, HAWAII
USDA SOIL CONSERVATION SERVICE
Sheet 7 of 7

APPENDIX C

Table C-1 (page 1 of 3)
Flood Discharge - Elevation - Frequency Data
Keopu Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
KE01	0+00	5.0	560	1120	1610	2460	5.5	5.8	6.1	6.4
KE02	1+40	9.5	560	1120	1610	2460	10.8	11.3	11.6	12.0
KE03	4+70	15.0	560	1120	1610	2460	18.3	19.8	20.7	21.2
KE04	8+70	34.0	560	1120	1610	2460	35.1	35.7	36.0	36.5
KE05	13+70	45.0	560	1120	1610	2460	51.0	52.5	53.0	53.8
KE06	20+20	95.0	560	1120	1610	2460	97.3	98.1	98.5	99.2
KE07	24+95	130.0	560	1120	1610	2460	134.5	136.0	167.0	138.2
KE08	31+95	200.0	560	1120	1610	2460	202.0	202.7	203.1	203.6
KE09	35+95	216.3	560	1120	1610	2460	218.2	220.3	221.3	222.4
KE10	36+79	218.0	530	1050	1570	2400	220.9	221.8	222.2	223.0
KE11	38+54	235.0	530	1050	1570	2400	237.2	238.0	238.4	238.9
KE12	45+04	295.0	530	1050	1570	2400	296.1	296.6	297.0	297.4
KE13	51+04	380.0	530	1050	1570	2400	381.1	381.8	382.1	382.5
KE14	62+54	490.0	530	1050	1570	2400	492.8	493.9	494.5	495.1
KE20	73+54	560.0	1000	2100	3010	4550	562.0	562.6	562.9	563.2
KE21	83+29	670.0	1000	2100	3010	7880	672.0	672.8	673.3	673.8
KE22	90+79	720.0	4000	2100	3010	4550	722.1	722.9	723.3	723.8
KE23	97+29	812.8	960	2050	2940	4470	815.5	817.5	819.3	821.0
KE24	98+04	820.0	960	2050	2940	4470	822.4	823.8	825.0	826.6
KE25	99+29	846.1	860	2050	2940	4470	848.8	850.8	852.2	854.2
KE26	102+04	878.4	960	2050	2940	4470	882.1	884.4	886.3	889.1
KE27	105+79	895.7	960	2050	2940	4470	898.8	900.9	902.5	904.5
KE28	110+29	934.2	960	2050	2940	4470	937.0	939.0	940.3	942.3
KE29	112+79	960.7	960	2050	2940	4470	962.8	964.4	965.6	967.2

Table C-1 (page 2 of 3)
Flood Discharge - Elevation - Frequency Data
Keopu Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
KE30	114+54	999.0	960	2050	2940	4470	1001.9	1003.8	1005.2	1007.0
KE31	117+29	1030.8	960	2050	2940	4470	1033.2	1034.9	1036.0	1037.9
KE32	119+54	1067.0	960	2050	2940	4470	1070.8	1073.0	1074.5	1077.5
KE33	122+29	1082.1	960	2050	2940	4470	1084.3	1085.6	1086.4	1088.1
KE34	124+04	1125.3	960	2050	2940	4470	1128.2	1129.8	1130.8	1133.0
KE35	125+29	1139.4	960	2050	2940	4470	1141.9	1143.3	1144.3	1146.3
KE36	128+04	1185.6	360	2050	2940	4470	1188.4	1189.6	1190.4	1192.2
KE37	139+29	1396.5	960	2050	2940	4470	1398.3	1400.8	1402.0	1403.9
KE38	143+29	1408.6	960	2050	2940	4470	1451.3	1453.0	1454.0	1455.5
KE39	146+79	1480.6	960	2050	2940	4470	1484.0	1486.1	1487.4	1489.8
KE40	147+19	1490.0	960	2050	2940	4470	1493.3	1495.1	1496.5	1499.5
KE41	147+44	1491.6	960	2050	2940	4470	1494.5	1496.0	1497.3	1500.0
KE42	147+69	1493.2	960	2050	2940	4470	1495.1	1496.6	1497.7	1500.2
KE43	147+94	1502.9	960	2050	2940	4470	1504.9	1506.6	1508.2	1511.7
KE44	148+04	1506.8	960	2050	2940	4470	1509.3	1510.9	1513.1	1518.2
KE45	148+10	1508.9	960	2050	2940	4470	1511.6	1514.1	1515.8	1518.7
KE46	148+19	1511.4	960	2050	2940	4470	1513.6	1515.0	1516.3	1518.8
KE47	148+34	1514.1	960	2050	2940	3800	1517.3	1519.0	1520.4	1520.9
KE48	148+61	1515.3	960	2050	2940	3800	1517.2	1518.9	1520.3	1520.8
KE49	149+11	1522.0	840	1840	2650	4050	1590.7	1591.4	1591.8	1592.6
KE50	152+11	1588.0	840	1840	2650	4050	1590.7	1591.4	1591.8	1592.6
KE51	154+21	1606.0	840	1840	2650	4050	1610.0	1611.1	1611.7	1612.6
KE52	157+71	1650.0	840	1840	2650	4050	1652.5	1653.4	1653.9	1654.6
KE53	168+21	1810.0	840	1840	2650	4050	1812.2	1813.0	1813.4	1813.9

Table C-1 (page 3 of 3)
Flood Discharge - Elevation - Frequency Data
Keopu Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
KEN01	0+00	4.5	590	1170	1680	2540	6.2	6.6	6.8	7.1
KEN02	6+00	30.0	590	1170	1680	2540	32.4	33.2	33.7	34.4
KEN03	11+75	65.0	590	1170	1680	2540	67.6	68.7	69.3	70.0
KEN04	18+75	115.0	590	1170	1680	2540	117.0	117.8	118.4	118.9
KEN05	25+75	145.0	590	1170	1680	2540	148.1	149.0	149.6	150.4
KEN06	26+85	149.7	590	1170	1680	2540	151.9	153.3	154.4	155.8
KEN07	28+05	153.3	590	1130	1630	2470	157.5	162.4	166.8	174.0
KEN08	32+05	180.0	550	1130	1630	2470	180.4	182.1	182.8	183.5
KEN09	38+05	225.0	550	1130	1630	2470	226.6	227.4	227.8	228.4
KEN10	49+30	330.0	550	1130	1630	2470	332.0	332.7	333.1	333.6
KEN11	58+30	410.0	550	1130	1630	2470	411.9	412.7	413.2	413.9
KEN12	66+80	500.0	550	1130	1630	2470	501.8	502.6	503.1	503.6
KE22.01	7+00	800.0	-	-	-	385	-	-	-	802.5
KE22.02	18+80	944.0	_	_	_	385	_	_	_	946.9
KE22.03	28+60	1070.0	_	_	_	385	_	_	_	1072.5
KE22.04	38+20	1244.0	_	_	_	385	_	_	_	1246.5
KE22.05	50+80	1430.0	_	_	_	385	_	_	_	1433.6
KE22.06	N/A	1230.0	_	_	_	385	_	_	_	1233.9

Table C-2 (page 1 of 2)
Flood Discharge - Elevation - Frequency Data
Hienaloli Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
HI01	0+00	1.0	1550	2690	3690	5180	4.7	6.2	7.2	7.2
HI02	2+20	3.8	1550	2690	3690	5180	7.2	8.6	9.8	10.0
HI03	9+00	18.7	1550	2690	3690	5180	21.4	22.6	23.7	24.9
HI04	13+30	42.8	1550	2690	3690	5180	45.1	46.4	47.5	49.0
HI05	14+60	58.5	1550	2690	3690	5180	61.0	62.3	63.4	65.2
HI06	15+20	64.6	1550	2690	3690	5180	67.3	68.5	69.6	71.6
HI07	19+00	96.2	1550	2690	3690	5180	98.7	100.4	101.9	104.2
HI08	20+95	117.8	1550	2690	3690	5180	120.7	123.2	125.5	128.4
HI09	22+95	140.0	1510	2640	3620	5100	142.3	145.5	147.3	149.2
HI10	29+30	175.7	1510	2640	3000	3000	180.3	181.2	181.5	181.5
HI11	34+45	196.0	1510	2640	3000	3000	199.1	199.4	199.6	199.6
HI12	39+20	215.0	1510	2640	3000	3000	215.8	217.8	218.2	218.2
HI13	42+35	242.6	1510	2650	3000	3000	241.8	248.1	249.8	249.8
HI14	43+25	244.0	1510	2650	3000	3000	244.6	246.9	249.5	249.5
HI15	44+75	247.2	1510	2650	3000	3000	251.7	253.6	254.1	254.1
HI16	53+75	310.0	1510	2650	3650	5140	314.9	316.1	316.9	318.0
HI17	61+00	340.0	1510	2650	3650	5140	347.7	349.3	350.4	351.7
HI18	67+50	400.0	1510	2650	3650	5140	406.5	408.4	409.6	411.0
HI19	73+65	470.0	1510	2650	3650	5140	473.6	475.3	476.3	477.2
HI20	79+15	528.0	1510	2650	3650	5140	533.1	534.3	535.1	536.1
HI21	85+40	570.0	1510	2650	3650	5140	574.3	574.5	574.7	575.2
HI22	92+90	660.0	1510	2650	3650	5140	663.6	664.4	665.0	665.6
HI23	98+40	700.0	970	1830	2520	3660	703.5	704.1	704.6	705.3
HI24	109+15	800.0	970	1830	2520	3660	802.5	802.8	803.1	803.6

Table C-2 (page 2 of 2)
Flood Discharge - Elevation - Frequency Data
Hienaloli Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
HI25	116+90	870.0	970	1830	2520	3660	872.6	874.0	874.6	875.3
HI26	122+90	950.0	970	1830	2520	3660	952.1	953.4	954.1	954.6
HI27	132+90	1134.0	970	1830	2520	3660	1139.2	1140.0	1140.6	1141.3
HI28	138+90	1200.0	970	1830	2520	3660	1204.2	1205.2	1205.8	1206.8
HI29	144+40	1290.0	970	1830	2520	3660	1290.8	1291.2	1291.5	1291.9
HI30	151+40	1390.0	970	1820	2520	3660	1392.9	1393.6	1394.0	1394.7
HI31	155+90	1461.5	970	1830	2520	3660	1465.3	1467.1	1468.2	1469.7
HI32	146+40	1483.8	900	1710	2340	3400	1488.3	1490.9	1492.4	1494.6
HI33	156+64	1488.4	900	1710	2340	3400	1490.2	1490.8	1492.2	1494.0
HI34	157+14	1502.0	900	1710	2340	3400	1508.2	1508.9	1509.4	1510.3
HI35	163+14	1570.0	900	1710	2340	3400	1573.2	1574.3	1574.9	1575.8
HI36	171+14	1660.0	900	1710	2340	3400	1665.2	1666.0	1666.6	1667.5
HI37	178+14	1730.0	900	1710	2340	3400	1734.8	1735.5	1735.9	1736.7
HI38	187+14	1850.0	900	1710	2340	3400	1855.0	1857.2	1858.7	1860.3
HIN10	29+95	167.7	-	-	630	2100	-	-	171.6	174.5
HIN11	34+95	191.4	-	-	630	2100	-	-	193.6	195.2
HIN12	38+95	215.0	-	-	630	2100	-	-	216.6	218.6
HIN13	41+70	238.3	-	-	650	2140	-	-	240.3	243.3
HIN14	42+60	240.2	-	-	650	2140	-	-	245.3	249.7
HIN15	44+10	245.2	-	-	650	2140	-	-	247.5	248.5

Table C-3 (page 1 of 4)
Flood Discharge - Elevation - Frequency Data
Waiaha Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
WAS01	0+00	5.0	1320	1950	2670	3710	5.5	5.7	6.0	6.2
WAS02	4+50	40.0	1320	1950	2670	3710	42.0	42.5	43.3	43.7
WAS03	7+50	54.0	1320	1950	2670	3710	54.0	54.7	55.0	55.2
WAS04	17+50	90.0	1320	1950	2670	3710	91.7	92.3	92.7	93.3
WAS05	27+50	140.0	1320	1950	2670	3710	143.0	143.9	144.6	145.4
WAS06	35+00	185.0	1320	1950	2670	3710	186.0	186.3	186.7	186.9
WAS07	35+50	192.0	1320	1950	2670	3710	193.7	194.2	194.8	195.3
WAS08	38+50	195.0	1320	1950	2670	3710	197.2	199.9	200.0	200.1
WAS09	45+50	250.0	1320	1950	2670	3710	252.5	253.4	254.0	254.9
WAS10	57+50	300.0	1320	1950	2670	3710	302.7	303.5	304.3	304.9
WAS11	59+50	302.4	1320	1950	2670	3710	308.7	309.8	310.5	310.9
WAS12	59+51	302.4	1320	1950	2670	3710	-	-	-	-
WAS13	60+74	307.0	1320	1950	2670	3710	-	-	-	-
WAS14	60+75	307.0	1320	1950	2670	3710	312.4	315.1	315.1	315.5
WAS15	61+75	310.0	1320	1950	2670	3710	312.7	313.5	314.3	315.0
WAS16	72+25	320.0	-	510	860	1530	320.0	323.0	324.7	326.6
WAS17	82+58	440.0	-	510	860	1530	440.0	440.4	440.8	441.3
WAS18	87+25	473.8	-	510	860	1530	473.8	476.7	477.7	478.8
WAS19	87+26	473.8	-	510	860	1530	-	-	-	-
WAS20	88+14	176.2	-	510	860	1530	-	-	-	-
WAS21	88+05	476.2	-	510	860	1530	476.2	479.0	480.9	483.0
WAS22	90+05	500.0	-	510	860	1530	500.0	502.3	503.0	504.2

Table C-3 (page 2 of 4)
Flood Discharge - Elevation - Frequency Data
Waiaha Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
WA01	0+00	2.9	2770	5190	7110	10650	10.5	12.7	14.3	16.2
WA02	0+30	5.0	2770	5190	7110	10650	13.3	16.0	17.2	18.7
WA03	0+80	6.6	2770	5190	7110	10650	16.4	18.8	20.0	21.5
WA04	3+80	15.0	2770	5190	7110	10650	19.0	20.0	20.7	22.5
WA05	8+55	35.0	2770	5190	7110	10650	39.3	40.4	40.9	41.6
WA06	10+80	55.0	1830	3330	4480	6620	58.3	59.8	60.8	62.0
WA07	14+55	95.0	1830	3330	4480	6620	97.2	98.3	98.8	99.3
WA08	22+05	151.6	1830	3330	4480	6620	154.8	157.4	158.3	159.3
WA09	22+55	155.6	1830	3330	4480	6620	162.8	165.6	166.2	167.4
WA10	22+97	156.1	2720	5250	7140	10660	163.0	164.9	165.7	167.0
WA11	23+47	162.1	2720	5250	7140	10660	164.0	164.9	165.3	165.5
WA12	28+47	320.0	2720	5250	7140	10660	324.2	325.8	326.+	327.7
WA13	33+97	350.6	2720	5250	7140	10660	352.8	355.7	357.4	359.7
WA14	34+97	352.5	2720	5250	7140	10660	354.3	355.8	357.0	359.5
WA15	36+47	360.0	1640	3150	4270	6370	362.3	363.3	363.8	364.3
WA16	43+47	430.0	1640	3150	4270	6370	432.8	433.8	434.4	435.3
WA17	47+47	449.0	1640	3150	4270	6370	453.0	454.0	454.5	455.3
WA18	47+73	449.8	1640	3150	4270	6370	453.5	454.5	455.2	455.7
WA19	51+73	480.0	1640	3150	4270	6370	484.3	486.0	487.0	488.3
WA20	60+48	558.9	2710	5240	7120	10610	563.6	565.3	566.3	567.0
WA21	64+73	579.9	2710	5240	7120	10610	584.8	586.5	587.3	588.3
WA22	68+98	600.0	2710	5240	7120	10610	603.5	605.0	605.8	606.7
WA23	76+23	660.0	2710	5240	7120	40610	663.5	664.8	665.3	665.8
WA24	81+98	682.7	2710	5240	7120	10610	693.0	692.2	693.3	695.0

Table C-3 (page 3 of 4)
Flood Discharge - Elevation - Frequency Data
Waiaha Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
WA25	83+23	684.1	2710	5240	7120	10610	694.4	698.4	700.4	703.4
WA26	83+73	686.4	2620	5560	7750	11880	690.0	693.4	695.7	698.8
WA27	86+48	728.0	2620	5560	7750	11880	732.2	734.2	735.2	736.5
WA28	91+48	840.0	2620	5560	7750	11880	844.6	846.7	847.5	848.9
WA29	96+73	920.0	2620	5560	7750	11880	926.5	928.8	931.1	931.3
WA30	105+73	1060.3	2620	5560	7750	11880	1064.8	1067.0	1068.1	1069.5
WA31	112+23	1170.0	2620	5560	7750	11880	1176.5	1178.6	1179.7	1181.5
WA32	117+73	1236.0	2620	5560	7750	11880	1242.5	1245.6	1246.8	1248.4
WA33	123+73	1340.0	2620	5560	7750	11880	1346.0	1348.0	1349.0	1350.4
WA34	130+48	1439.7	2620	5560	7750	11880	1443.8	1445.7	1446.7	1447.7
WA35	133+98	1477.0	1420	3360	4530	7080	1480.3	1482.3	1482.9	1484.0
WA36	134+48	1488.3	1420	3360	4530	7080	1494.0	1498.5	1500.4	1503.5
WA37	134+72	1485.8	1420	3360	4530	7080	1490.0	1494.8	1497.4	1501.4
WA38	135+22	1492.6	1420	3360	4530	7080	1496.3	1498.5	1499.2	1500.3
WA39	141+47	1600.0	1420	3360	4530	7080	1604.2	1606.3	1607.2	1608.5
WA40	148+97	1730.0	1420	3360	4530	7080	1734.5	1737.5	1738.5	1740.4
WA41	154+47	1810.0	1420	3360	4530	7080	1814.7	1818.3	1819.5	1821.5
WA42	159+47	1900.0	1420	3360	4530	7080	1905.3	1908.0	1909.2	1911.0
WA43	166+97	1970.0	1420	3360	4530	7080	1974.5	1976.7	1977.5	1979.0
WA34.01	3+00	1479.0	1330	2400	3500	5150	1480.2	1481.0	1482.2	1484.0
WA34.02	3+50	1485.7	1330	2400	3500	5150	1495.5	1498.5	1500.0	1502.2
WA34.03	3+75	1486.2	1330	2400	3500	5150	1495.5	1498.3	1500.0	1502.7

Table C-3 (page 4 of 4)
Flood Discharge - Elevation - Frequency Data
Waiaha Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
WA34.04	4+25	1493.8	1330	2400	3500	5150	1498.2	1499.1	1500.1	1500.7
WA34.05	10+00	1580.0	1330	2400	3500	5150	1583.4	1584.3	1584.9	1585.7
WA34.06	17+50	1700.0	1330	2400	3500	5150	1704.3	1705.4	1706.3	1707.4
WA34.07	24+50	1800.0	1330	2400	3500	5150	1803.4	1804.2	1804.8	1805.5
WA5.01	2+50	45.0	880	1790	2500	3820	47.9	48.6	48.9	49.2
WA5.02	8+30	106.0	880	1790	2500	3820	108.8	109.3	109.7	110.2
WA5.03	8+80	125.9	880	1790	2500	3820	133.8	136.0	137.4	139.0
WA5.04	9+20	126.7	880	1790	2500	3820	130.8	132.4	133.4	134.6
WA5.05	9+70	129.6	880	1790	2500	3820	135.8	137.4	138.0	138.8
WA14.01	5+30	380.0	1010	2100	2850	4240	382.0	382.6	382.9	383.3
WA14.02	7+55	422.3	1010	2100	2850	4240	428.4	431.2	432.4	434.0
WA14.03	7+83	424.4	1010	2100	2850	4240	427.8	429.6	429.7	429.8
WA14.04	17+83	470.0	1010	2100	2850	4240	472.8	473.8	474.3	475.1
WA14.05	24+08	500.0	1010	2100	2850	4240	502.7	503.6	504.0	504.7

Table C-4 (page 1 of 4)
Flood Discharge - Elevation - Frequency Data
Holualoa/Horseshoe Bend Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
HO01	0+00	5.0	900	1750	2590	4070	5.3	5.5	5.6	5.9
HO02	0+70	5.9	900	1750	2590	4070	10.5	10.6	10.8	11.5
HO03	1+10	7.2	900	1750	2590	4070	10.5	10.6	10.7	11.2
HO04	4+40	18.1	900	1750	2590	4070	19.5	19.8	20.1	20.5
HO05	10+90	30.6	900	1750	2590	4070	31.2	32.8	33.8	34.6
HO06	16+65	63.0	900	1750	2590	4070	64.4	65.1	65.6	66.2
HO07	23+90	126.0	900	1750	2590	4070	129.6	130.9	131.9	132.9
HO08	28+40	157.2	1250	1990	2790	4150	161.6	162.6	163.6	164.8
HO09	33+15	195.0	620	1040	1500	2300	198.0	198.7	199.3	200.1
HO10	38+65	239.0	620	1040	1500	2300	241.1	241.4	241.8	242.2
HO11	41+15	264.3	620	1040	1500	2300	268.0	269.3	270.2	271.2
HO12	41+65	274.3	620	1040	1500	2300	278.4	279.4	279.8	280.0
HO13	42+15	280.4	620	1040	1500	2300	284.5	286.0	286.8	287.6
HO14	42+65	288.5	600	1020	1480	2280	292.3	293.1	293.5	294.0
HO15	44+05	302.5	600	1020	1480	2280	305.3	306.4	307.6	309.4
HO16	45+25	319.0	600	1020	1480	2280	320.6	321.3	321.9	323.0
HO17	51+75	390.0	600	1020	1480	2280	392.2	392.8	393.2	393.9
HO18	57+25	430.0	600	1020	1480	2280	432.1	432.6	433.0	433.5
HO19	62+75	470.0	600	1020	1480	2280	472.6	473.7	473.7	474.4
HO20	67+75	550.0	600	1020	1480	2280	552.1	552.6	553.1	553.7
HO21	72+80	640.0	600	1020	1480	2280	642.8	643.6	644.2	645.0
HO22	76+75	727.0	600	1020	1480	2280	730.0	730.7	731.3	732.2
HO23	85+25	848.0	600	1020	1480	2280	851.0	852.3	853.3	854.8
HO24	92+25	959.2	600	1020	1480	2280	962.3	963.0	963.5	964.2

Table C-4 (page 2 of 4)
Flood Discharge - Elevation - Frequency Data
Holualoa/Horseshoe Bend Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
HO25	92+75	973.3	340	830	1240	1970	977.0	979.5	980.8	982.3
HO26	93+00	975.3	340	830	1240	1970	977.0	978.2	979.1	980.8
HO27	93+50	997.5	340	830	1240	1970	999.0	999.8	1000.2	1001.0
HO28	98+75	1090.0	340	830	1240	1970	1091.9	1092.2	1092.5	1092.9
HO29	105+25	1180.0	340	830	1240	1970	1181.9	1182.6	1183.1	1183.7
HO30	109+50	1250.0	340	830	1240	1970	1252.0	1252.4	1252.7	1253.2
HO31	115+75	1338.1	340	830	1240	1970	1340.2	1341.9	1343.0	1344.3
HO32	116+25	1343.8	250	660	1010	1630	1345.2	1348.2	1350.0	1352.0
HO33	116+50	1344.4	250	660	1010	1630	1344.5	1349.1	1351.4	1353.4
HO34	117+00	1347.8	250	660	1010	1630	1351.6	1352.5	1353.3	1354.4
HO35	123+50	1423.8	250	660	1010	1630	1426.2	1427.4	1428.3	1429.4
HO36	129+00	1480.0	250	660	1010	1630	1481.8	1482.9	1483.6	1484.3
HO37	137+00	1600.0	250	660	1010	1630	1601.4	1602.9	1603.6	1604.4
HO38	145+75	1700.0	250	660	1010	1630	1702.4	1703.1	1703.7	1704.5
HO29.01	4+50	1250.0	30	70	110	180	1251.4	1251.4	1251.5	1251.6
HO29.02	10+00	1330.0	30	70	110	180	1330.2	1330.3	1330.4	1330.6
HO29.03	12+75	1360.0	30	70	110	180	1360.4	1360.4	1360.6	1360.6
HO29.04	16+75	1390.0	30	70	110	180	1391.4	1391.5	1391.6	1391.8
HO5.01	0+00	75.0	-	-	-	300	-	-	-	75.6
HO5.02	7+50	120.0	-	-	-	300	-	-	-	120.7
HO5.03	15+50	165.0	-	-	-	300	-	-	-	167.2

Table C-4 (page 3 of 4)
Flood Discharge - Elevation - Frequency Data
Holualoa/Horseshoe Bend Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
HO8.01	8+25	203.0	640	960	1310	1910	206.9	207.6	208.2	209.0
HO8.02	11+25	224.8	640	960	1310	1910	228.3	228.8	229.4	203.3
HO8.03	19+25	258.0	640	960	1310	1910	261.0	261.7	262.4	263.4
HO8.04	19+75	258.0	640	960	1310	1910	260.7	261.0	261.2	261.4
HO8.05	25+25	290.0	640	960	1310	1910	292.1	292.6	293.1	293.6
HO8.06	27+50	320.0	640	960	1310	1910	322.2	322.5	322.9	323.4
HO8.07	29+75	334.0	600	910	1260	1870	338.5	339.1	339.8	341.0
HO8.08	30+85	342.0	600	910	1260	1870	342.6	342.9	343.2	343.6
HO8.09	34+10	380.0	600	910	1260	1870	382.0	382.3	382.6	383.2
HO8.10	44+35	450.0	600	910	1260	1870	452.3	452.8	453.2	453.6
HO8.11	51+60	520.0	600	910	1260	1870	522.0	522.3	522.6	523.1
HO8.12	58+10	600.0	600	910	1260	1870	602.7	602.9	603.2	603.6
HO8.13	61+60	650.0	600	910	1260	1870	652.3	652.7	653.2	653.8
HO8.14	66+60	720.0	600	910	1260	1870	722.5	722.9	723.4	724.1
HO8.15	67+10	718.7	600	910	1260	1870	722.9	723.5	724.2	725.2
HO8.16	67+60	720.7	600	910	1260	1870	721.7	722.0	722.4	723.1
HO8.17	69+60	760.0	600	910	1260	1870	763.3	763.8	764.4	765.2
HO8.18	71+60	800.3	600	910	1260	1870	801.9	802.2	802.5	803.0
HO8.19	74+10	828.5	600	910	1260	1870	830.4	831.1	831.7	832.4
HO8.20	75+60	855.6	600	910	1260	1870	859.2	859.8	860.5	861.3
HO8.21	76+10	861.2	330	690	1010	1640	863.8	865.3	866.5	868.5
HO8.22	76+42	862.2	330	690	1010	1640	864.0	869.0	869.8	871.1
HO8.23	76+92	872.4	330	690	1010	1640	875.4	876.1	876.6	877.3
HO8.24	82+67	1000.0	330	690	1010	1640	1002.3	1002.6	1002.8	1003.2

Table C-4 (page 4 of 4)
Flood Discharge - Elevation - Frequency Data
Holualoa/Horseshoe Bend Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
HO8.25	88+17	1090.0	330	690	1010	1640	1091.8	1092.2	1092.5	1093.0
HO8.26	95+67	1230.0	330	690	1010	1640	1232.4	1232.7	1232.9	1233.4
HO8.27	102+87	1340.0	330	690	1010	1640	1341.5	1342.4	1343.0	1343.5
HO8.28	110+17	1441.8	330	690	1010	1640	1443.7	1444.1	1444.4	1444.9
HO8.29	110+67	1443.9	200	540	830	1440	1448.6	1449.0	1449.3	1450.0
HO8.30	111+05	1447.4	200	540	830	1440	1451.7	1451.8	1451.8	1451.8
HO8.31	111+55	1449.0	200	540	830	1440	1450.2	1450.5	1450.7	1451.2
HO8.32	118+05	1576.0	200	540	830	1440	1577.7	1578.4	1578.9	1580.0

Table C-5 (page 1 of 3)
Flood Discharge - Elevation - Frequency Data
Kaumalumalu Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
KAU01	0+00	6.1	1040	2750	4040	6840	8.1	9.4	9.9	10.3
KAU02	0+50	12.2	1040	2750	4040	6840	13.0	13.3	13.5	13.9
KAU03	1+00	14.2	1040	2750	4040	6840	13.9	14.6	14.9	15.5
KAU04	7+00	41.7	1040	2740	4040	6840	43.1	43.6	43.9	44.3
KAU05	13+75	50.0	1040	2740	4040	6840	54.8	56.5	57.4	58.9
KAU06	18+75	75.0	1040	2750	4040	6840	76.0	76.6	77.0	77.8
KAU07	23+75	115.0	1040	2750	4040	6840	116.5	117.3	117.8	118.7
KAU08	30+75	186.0	990	2680	3810	6160	182.6	183.8	184.3	185.3
KAU09	34+75	220.0	990	2680	3810	6160	222.7	224.0	224.5	225.3
KAU10	42+25	322.6	990	2680	3810	6160	324.6	325.3	325.7	326.4
KAU11	46+25	400.0	990	2680	3810	6160	403.6	404.9	405.3	405.9
KAU12	47+75	438.7	990	2680	3810	6160	446.3	450.0	450.9	451.7
KAU13	48+25	451.0	990	2680	3810	6160	451.5	452.4	452.6	453.5
KAU14	48+75	463.4	990	2680	3810	6160	469.4	471.0	471.7	472.9
KAU15	53+75	530.0	1100	3040	4340	6630	534.3	535.3	535.7	536.8
KAU16	55+25	560.0	1100	3040	4340	6630	562.9	564.0	564.5	565.4
KAU17	60+75	680.0	1100	3040	4340	6630	681.3	682.4	682.4	683.3
KAU18	68+75	800.00	1100	3040	4340	6630	803.6	805.3	806.1	807.6
KAU19	74+25	860.0	1100	3040	4340	6630	863.4	865.2	866.2	868.0
KAU20	79+50	930.0	1100	3040	4340	6630	933.6	934.5	934.8	935.3
KAU21	86+00	999.9	1100	3040	4340	6630	1005.7	1009.0	1009.4	1010.5
KAU22	93+50	1052.4	1100	3040	4340	6630	1055.5	1056.6	1057.1	1057.9
KAU23	94+00	1073.5	1080	3010	4290	6500	1076.4	1079.3	1080.7	1082.6
KAU24	94+32	1076.4	1080	3010	4290	6500	1077.6	1079.0	1081.4	1083.5

Table C-5 (page 2 of 3)
Flood Discharge - Elevation - Frequency Data
Kaumalumalu Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
KAU25	94+82	1085.2	1080	3010	4290	6500	1088.5	1090.0	1091.3	1093.6
KAU26	100+82	1140.0	1080	3010	4290	6500	1143.1	1144.5	1145.1	1146.1
KAU27	104+12	1206.6	1050	2920	4050	6600	1207.1	1208.6	1209.1	1209.9
KAU28	110+62	1320.0	1050	2920	4050	6600	1324.0	1324.9	1325.0	1326.0
KAU29	116+12	1430.0	1050	2920	4050	6600	1433.0	1434.3	1434.8	1435.7
KAU30	121+62	1530.0	1050	2920	4050	6600	1535.1	1537.0	1538.0	1539.8
KAU7.01	6+00	175.0	110	170	230	630	175.6	175.8	176.0	176.6
KAU7.02	11+00	240.0	110	170	240	630	240.4	240.6	240.7	241.9
KAU7.03	16+00	290.0	110	170	230	630	290.9	291.1	291.4	292.1
KAU7.04	21+50	350.0	110	170	230	630	351.0	351.1	351.4	352.3
KAU7.05	26+50	400.0	110	170	230	630	401.0	401.2	401.5	402.4
KAU15.01	3+75	600.0	110	180	240	560	600.9	601.1	601.2	601.7
KAU15.02	8+25	700.0	110	180	240	560	700.2	700.3	700.4	700.6
KAU15.03	13+25	800.0	110	180	240	560	801.2	801.4	801.5	802.1
KAU15.04	20+00	900.0	110	180	240	560	901.1	901.5	901.7	902.3
KAU15.05	25+50	950.0	110	180	240	560	951.6	951.9	952.3	953.2
KAU15.06	31+75	1000.0	110	180	240	560	1000.5	1000.8	1001.4	1002.9
KAU15.07	39+00	1070.0	110	180	240	560	1071.4	1071.6	1071.9	1072.6
KAU15.08	41+00	1086.1	110	180	240	560	1086.6	1086.9	1087.2	1087.9
KAU15.09	41+50	1097.3	110	180	240	560	1101.6	1102.5	1103.4	1105.7
KAU15.10	41+75	1098.4	110	180	240	560	1099.0	1099.2	1099.6	1100.6
KAU15.11	42+25	1105.4	110	180	240	560	1107.0	1107.2	1107.7	1108.6
KAU15.12	47+75	1158.0	110	180	240	560	1160.6	1161.0	1161.3	1162.4

Table C-5 (page 3 of 3)
Flood Discharge - Elevation - Frequency Data
Kaumalumalu Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
KAU27.01	6+50	1300.0	80	230	330	500	1302.4	1302.7	1302.9	1303.2
KAU27.02	12+00	1410.0	80	230	330	500	1412.1	1412.4	1412.6	1412.8

Table C-6 (page 1 of 2)
Flood Discharge - Elevation - Frequency Data
Kawanui/Lehuula Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
KL01	0+00	10.0	290	460	590	1090	11.2	11.3	11.4	11.6
KL02	5+00	40.0	290	460	590	1090	42.5	42.7	42.9	43.5
KL03	9+00	100.0	290	460	590	1090	101.4	101.8	102.1	102.7
KL04	13+00	160.0	290	460	590	1090	161.7	161.9	162.0	162.3
KL05	18+25	225.0	290	460	590	1090	226.8	227.0	227.1	227.6
KL06	20+00	240.0	290	460	590	1090	241.5	241.7	241.8	242.4
KL07	23+00	275.0	290	460	590	1090	276.5	276.7	276.8	277.4
KL08	27+75	345.0	290	460	590	1090	346.6	346.8	347.0	347.6
KL09	32+75	400.0	290	460	590	1090	401.5	401.7	401.8	402.3
KL10	41+00	500.0	290	460	590	1090	501.1	501.3	501.5	501.8
KL11	46+00	555.0	290	460	590	1090	556.4	556.5	556.7	557.1
KL12	51+00	640.0	60	260	430	880	641.4	641.5	641.7	642.1
KL13	55+75	690.0	60	260	430	880	691.1	691.3	691.4	691.7
KL14	60+50	760.0	60	260	430	880	761.1	761.3	761.5	761.9
KL15	70+25	910.0	60	260	430	880	911.1	911.2	911.4	911.7
KL16	75+25	990.0	60	260	430	880	991.1	991.3	991.5	991.9
KL17	79+75	1050.0	60	260	430	880	1051.0	1051.3	1051.6	1052.1
KL18	87+35	1130.0	30	110	190	440	1131.0	1131.1	1131.2	1131.4
KL19	90+85	1190.0	30	110	190	440	1191.2	1191.3	1191.4	1191.7
KL20	95+85	1290.0	30	110	190	440	1290.8	1290.9	1291.0	1291.4
KL21	99+85	1330.0	30	110	190	440	1331.1	1331.2	1331.3	1331.6
KL22	103+85	1380.0	30	110	190	440	1380.1	1380.2	1380.3	1380.6
KL23	108+60	1438.6	30	110	190	440	1439.0	1439.1	1439.2	1439.4
KL24	109+00	1445.6	30	110	190	440	1447.4	1447.6	1447.7	1448.2

Table C-6 (page 2 of 2)
Flood Discharge - Elevation - Frequency Data
Kawanui/Lehuula Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
KL25	109+40	1445.6	30	110	190	430	1447.5	1447.6	1447.7	1448.0
KL26	109+80	1445.6	30	110	190	430	1446.8	1446.9	1447.1	1447.6
KL27	115+05	1500.0	30	110	190	430	1501.0	1501.1	1501.2	1501.4
KL28	120+05	1550.0	30	110	190	430	1551.0	1551.1	1551.2	1551.5
KL29	125+55	1600.0	30	110	190	430	1601.6	1601.7	1601.8	1602.2
KL30	130+55	1674.0	30	110	190	430	1675.1	1675.2	1675.3	1675.5
KL31	135+80	1740.0	30	110	190	430	1740.1	1740.2	1740.3	1740.5
KL17.01	4+25	1150.0	60	200	280	480	1151.7	1151.8	1151.9	1152.0
KL17.02	10+75	1200.0	60	200	280	480	1200.2	1200.3	1200.4	1200.6
KL17.03	14+75	1250.0	60	200	280	480	1250.8	1251.0	1251.2	1251.3
KL17.04	21+75	1320.0	60	200	280	480	1320.8	1321.0	1321.1	1321.3
KL17.05	26+25	1380.0	60	200	280	480	1381.0	1381.2	1381.3	1381.4
KL17.06	31+25	1440.0	60	190	270	460	1440.4	1440.6	1440.7	1440.8
KL17.07	31+40	1447.5	60	190	270	460	1450.3	1450.5	1450.6	1450.8
KL17.08	31+80	1447.5	60	190	270	460	1450.3	1450.4	1450.6	1450.8
KL17.09	31+95	1447.5	60	190	270	460	1450.4	1450.5	1450.6	1450.8
KL17.10	37+95	1490.0	60	190	270	460	1490.7	1490.9	1491.0	1491.1
KL17.11	43+45	1550.0	60	190	270	460	1551.5	1551.6	1551.7	1551.9
KL17.12	48+45	1600.0	60	190	270	460	1600.8	1600.9	1601.0	1601.1
KL17.13	53+20	1650.0	60	190	270	460	1651.1	1651.2	1651.3	1651.4
KL17.14	59+45	1720.0	60	190	270	460	1720.4	1720.5	1720.6	1720.8

Table C-7 (page 1 of 1)
Flood Discharge - Elevation - Frequency Data
Kainaliu Drainageway

Number	Station	Streambed Elevation (Ft. MSL)	Peak Discharge Cubic Feet Per Second (cfs) Year 10	50	100	500	Water Surface Elevation Feet Mean Sea Level (MSL) Year 10	50	100	500
KA01	0+00	5.0	200	360	610	1460	6.4	6.7	7.1	7.9
KA02	9+00	50.0	200	360	610	1460	51.5	51.9	52.4	53.4
KA03	14+75	125.0	200	360	610	1460	125.6	126.3	126.9	127.7
KA04	22+25	215.0	200	360	610	1460	216.3	217.6	218.3	219.4
KA05	26+75	275.0	200	360	610	1460	276.5	276.9	277.6	278.3
KA06	32+75	365.0	200	360	610	1460	366.6	367.0	367.4	368.4
KA07	39+75	435.0	200	360	610	1460	436.8	437.1	437.6	438.5
KA08	46+00	525.0	200	360	610	1460	526.5	526.8	527.5	528.5
KA09	52+75	600.0	200	360	610	1460	601.5	601.6	601.8	602.4
KA10	59+00	690.0	200	360	610	1460	691.3	691.6	692.0	692.8
KA11	65+25	790.0	200	360	610	1460	790.4	791.3	791.9	792.8
KA12	72+50	900.0	200	360	610	1460	901.3	901.4	901.5	902.0
KA13	80+25	1020.0	200	360	610	1460	1020.3	1021.2	1021.9	1022.7
KA14	85+75	1110.0	200	360	610	1460	1110.2	1110.3	1110.4	1110.8
KA15	91+00	1170.0	200	360	610	1460	1172.1	1172.3	1172.5	1173.4
KA16	95+75	1250.0	200	360	610	1460	1252.3	1252.3	1252.4	1252.6
KA17	109+50	1380.0	200	360	610	1460	1381.2	1381.6	1382.0	1382.9
KA18	114+75	1440.0	5	250	640	1550	1440.1	1440.1	1440.2	1440.4
KA19	123+00	1500.0	5	250	640	1550	1500.2	1500.2	1500.3	1500.4
KA20	130+50	1590.0	5	250	640	1550	1590.3	1590.4	1590.6	1591.0

APPENDIX D

APPENDIX D-1
NORTH KONA FLOOD PLAIN MANAGEMENT STUDY
DRAINAGEWAY MAINTENANCE INVENTORY

DRAINAGEWAY	ELEVATION (MSL)	CONDITION OF DRAINAGEWAY AND REMARKS	MAINTENANCE REQUIRED
Keopu	1500 (Mamalahoa)	Flow splits into several streams and goes through Keopu Heights Subdivision. Rejoins at elevation 800.	Channelize flow
	800	Flow splits into two streams at elevation 600'. The north branch goes into Kailua town by King Kam, while south branch flows by Hale Halawai.	Channelize flow
	Alii Dr.		

APPENDIX D-2
NORTH KONA FLOOD PLAIN MANAGEMENT STUDY
DRAINAGEWAY MAINTENANCE INVENTORY

DRAINAGEWAY	ELEVATION (MSL)	CONDITION OF DRAINAGEWAY AND REMARKS	MAINTENANCE REQUIRED
Hienaloli Stream	1500 (Mamalahoa Hwy.)	Streambed well defined down to bedrock with 10-20' holes in some areas. Rocks, boulders and trash deposited at downstream end of holes. Left bank of stream is piled up with Christmas berry trees from land clearing for avocado farm adjacent to stream.	Remove Christmas berry trees
	1400	Stream well defined with some rocks and boulders. Kukui trees, monkey pod, and thorny lantana along streambed.	None
	150 (old railroad)	Stream defined, meanders, splits, and rejoins at about elevation 300.	None
	140 (SCS Keopu Basin)		

APPENDIX D-3
NORTH KONA FLOOD PLAIN MANAGEMENT STUDY
DRAINAGEWAY MAINTENANCE INVENTORY

DRAINAGEWAY	ELEVATION (MSL)	CONDITION OF DRAINAGEWAY AND REMARKS	MAINTENANCE REQUIRED
Waiaha	1500 (Mamalahoa Hwy.)	Clean streambed that is well defined down to bedrock.	None
	1100	Streambed splits and joins together again at about elevation 900. Large boulders, some 8' in diameter, with huge scoured-out depressions 10-20' deep.	Remove boulders from streambed
	750	Streambed slope is flat and rocks and boulders have been deposited choking stream just above the old railroad.	Remove rocks and boulders
	700 (old railroad bridge)	Some rocks and boulders deposited in streambed.	None
	590	Flow splits here going to three culverts. Streams not well defined and meander.	Channelize flows to three culverts on Hualalai Road
	400-500 (Hualalai Rd.)	No defined streambed. Flow is overland, sheet type.	Channelize flow
	133 (Kuakini Hwy.)	Streambed is defined with rock, debris, and sediment. Overgrown with koa haole and elephant grass.	Clean out streambed
	18 (Alii Dr.)		

APPENDIX D-4
NORTH KONA FLOOD PLAIN MANAGEMENT STUDY
DRAINAGEWAY MAINTENANCE INVENTORY

DRAINAGEWAY	ELEVATION (MSL)	CONDITION OF DRAINAGEWAY AND REMARKS	MAINTENANCE REQUIRED
Horseshoe Bend	1460 (Mamalahoa Hwy.)	Streambed well defined but overgrown with california grass. Very little sediment or debris.	None
	1230	Flow splits at elevation 1230' with north branch flowing down an old cattle chute bounded on each side by rock walls 5' apart. Flow seems minimal in the north branch. Main drainageway is the south branch. They both meet just below Hualalai Road. Drainageway of south branch is well defined but overgrown with elephant and california grasses in some areas.	Remove grass and debris
	850 (Haualalai Rd.)	Streambed fairly well defined.	None
	260 (Kuakini Hwy.)	Well defined diversion overgrown with guinea grass. Merges with Holualoa drainageway at elevation 160'.	Remove grass
	160		

APPENDIX D-5
NORTH KONA FLOOD PLAIN MANAGEMENT STUDY
DRAINAGEWAY MAINTENANCE INVENTORY

DRAINAGEWAY	ELEVATION (MSL)	CONDITION OF DRAINAGEWAY AND REMARKS	MAINTENANCE REQUIRED
Holualoa Stream	1350 (Mamalahoa Hwy.)	Streambed well defined to bedrock. Overgrown with elephant and california grasses in some areas.	Remove grass
	970 (Hualalai Rd.)	Drainageway well defined to bedrock with some 5-8' waterfalls. Very little sediment. Some areas overgrown with elephant and california grasses.	Remove grass
	500	Streambed fairly well defined on steeper slopes but spreads out on flatter slopes. Overgrown with koa haole, castor beans, lantana, air plants, and monkey pod. Rocks and debris evident.	Remove brush and trees
	280 (Kuakini Hwy.)	Drainageway spreads out with large rocks and debris evident. Overgrown with guinea grass, kiawe and koa haole.	
	160	Merges with Horseshoe Bend diversion which is down to bedrock. Guinea grass an koa haole growth is evident. No debris and sediment.	None
	30	Flow spreads out and drainageway is undefined. Koa haole trees, debris consisting of rocks, and precast concrete tiles and beams clog diversion between elevation 20-30'. Undersized culvert at Alii Dr.	Clean out debris and channelize flow. Install culvert at Alii Dr.
	Alii Dr.		

APPENDIX D-6
NORTH KONA FLOOD PLAIN MANAGEMENT STUDY
DRAINAGEWAY MAINTENANCE INVENTORY

DRAINAGEWAY	ELEVATION (MSL)	CONDITION OF DRAINAGEWAY AND REMARKS	MAINTENANCE REQUIRED
Kaumalumalu (North Br.)	1100 (Mamalahoa Hwy.)	Drainageway is well defined. Water hasn't been flowing down this drainageway since SCS built a diversion above Mamalahoa Highway to divert flow into the south branch.	None
	520		
Kaumalumalu (South Br.)	1300	Defined streambed overgrown with buffalo, pangola, and california grasses.	None
	1200	Well defined streambed down to bedrock.	None
	1100 (Mamalahoa Hwy.)		
	1080	Well defined streambed down to bedrock with elephant, pangola, and kikuyu grasses. Very little sediment.	None
	720	Stream splits and rejoins main branch at about elevation 540'. Overgrown with elephant and pangola grasses.	Clean out grass
	Kuakini Hwy. (455)	Streambed well defined down to bedrock. No culvert at Kuakini Highway.	Install culvert
	390	Drainageway poorly defined and existing flood plain is about 130' wide at elevation 390' and 300' wide at elevation 80'. Below 80' elevation drainageway is undefined and flow spreads out. No culvert at Alii Drive.	Channelize flow and install culvert at Alii Dr.
	Alii Dr.		

APPENDIX E

APPENDIX E
NORTH KONA FLOOD PLAIN MANAGEMENT STUDY
BENCH MARK TABLES

BENCH MARK NO.	ELEVATION (MSL)	DESCRIPTION
1	14.05	Brass pin in concrete on centerline Alii Drive (P.C. 175+61.04).
2	457.30	Top of nail on telephone pole #91 makai side of Kuakini Highway by Kaumalumalu Drainageway.
3	1088.84	"($\underline{\bar{}}$)" cut in northwest corner of makai concrete headwall for 40' X 7.5' concrete culvert of Kaumalumalu Drainageway at Mamalahoa Highway.
4	11.48	"($\underline{\bar{}}$)" cut in northeast corner of makai concrete headwall for 5.5' X 3' concrete culvert of Holualoa Drainageway at Alii Drive.
5	868.43	Top of roof nail on pole #19 on mauka side of Hualalai Road, 60 feet northwest of two 60" RCP culverts for Horseshoe Bend Drainageway at Hualalai Road.
6	1353.40	"+" cut in south end of mauka concrete headwall for 6.5' X 10' CRM culvert of Holualoa Drainageway at Mamalahoa Highway.
7	1455.0	"+" cut in south end of mauka concrete headwall for 4' X 6' CRM culvert of Horseshoe Bend Drainageway at Mamalahoa Highway.
8	1498.28	Top of brass screw at south end of mauka concrete headwall for 20' X 8' concrete culvert of Waiaha(south) Drainageway at Mamalahoa Highway.
9	431.00	"+" cut in south end of mauka concrete headwall for two 60" CMP culverts of Waiaha Drainageway at Hualalai Road.
10	162.76	"+" cut in northeast corner of mauka concrete headwall for 5' X 5' concrete culvert of Waiaha Drainageway at Kuakini Highway.
11	18.46	"+" on north end of bridge railing post of makai concrete headwall for two 10' X 8' concrete culverts of Waiaha Drainageway at Alii Drive.
12	1501.98	"+" cut in southwest end of mauka concrete headwall for two 10' X 8.5' concrete culverts of Hienaloli Drainageway at Mamalahoa Highway.

13	1447.06	"(_)" cut in northwest corner of mauka concrete headwall for 48" RCP culvert of Kawanui Drainageway at Mamalahoa Highway.
14	1445.70	"(_)" cut in north corner of mauka concrete headwall for 30" CMP culvert of Lehuula Drainageway at Mamalahoa Highway.
15	8.00	USGS brass cap at west end of Kailua seawall.
16	1524.67	"+" cut in south corner of makai concrete headwall for 2 - 10.5' X 6' concrete culvert of Keopu Drainageway at Mamalahoa Highway.

APPENDIX F

GLOSSARY

Cubic Feet Per Second--Rate of fluid flow at which one cubic foot of fluid passes a measuring point in one second(cfs).

Discharge--The rate of flow or volume per unit of time. In this report discharge is expressed in cubic feet per second(cfs).

Drainageway--A natural or artificial watercourse that confines or conducts continuously or periodically flowing water.

Flood--An overflow of water onto lands not normally covered by water. The inundation is temporary and the land is adjacent to and inundated by overflow from a stream or ocean.

Flood Frequency--An expression of how often a flood event of a given magnitude will, on the average, be equaled or exceeded. The word "frequency" often is omitted in discussing a flood event for the purpose of abbreviation.

Examples:

10-year flood or 10-year frequency flood--The flood which can be expected to be equaled or exceeded on an average of once in 10 years; and which would have a 10 percent chance of being equaled or exceeded in any given year.

50-year flood--.....two percent chance....in any given year.

100-year flood--.....one percent chance.....in any given year.

500-year flood--.....two-tenths percent chance....in any given year.

Flood Peak or Peak Discharge--The highest stage or discharge attained during a flood.

Flood Plain, Flood Prone or Flood Hazard Area--Land adjoining a stream which has been or may be covered by water.

Flood Plain Encroachment--Placement of fill or structures in the flood plain which may impede flood flow and cause backwater.

Flood Proofing--A combination of structural provisions, changes or adjustments to properties and structures subject to flooding for the reduction or elimination of flood damages to properties, water and sanitary facilities, structures and contents of buildings in a flood hazard area.

Flood Routing--Computation of the changes in the rise and fall in streamflow as a flood moves downstream. The results provide hydrographs of discharge versus time at given points on the stream.

Frequency-Discharge Curve--A plotted curve showing peak discharges versus various flood frequencies.

Hydrograph--A plotted curve showing the rise and fall of flood discharge with respect to time at a specific point on a stream.

Stage-Discharge Curve--A plotted curve showing elevations resulting from a range of discharges at a point on a stream.

Top Width-Discharge Curve--A plotted curve showing top widths resulting from a range of discharges at a point on a stream.

Valley or Channel Cross Section--The relationship of the elevation of the ground to the horizontal distance across a valley or channel perpendicular to the direction of flow.

Watershed--A drainage basin or area which collects runoff and transmits it to the outlet of the basin.

Watershed Boundary--The divide separating one drainage basin from another.

Water Surface Profile--The relationship of water surface elevation to stream channel elevation at points along a stream, generally drawn to show the water surface elevation for the peak of a specific flood, but may be prepared for conditions at any given time.